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PSYCHE

VOL. XXXII. AUGUST-OCTOBER 1925 Nos. 4-5

# THE EXTERNAL ANTATOMY OF THE HEAD AND ABDOMEN OF THE ROACH, *PERIPLANETA AMERICANA*[1]

By G. C. Crampton, Ph. D.

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Despite the fact that the very sight of a roach engenders in the minds of many people a feeling of repugnance and disgust, while others consider that roaches are too insignificant to be worthy of one's serious attention, roaches are nevertheless extremely "ancient and honorable" creatures in the sight of the great mother Nature. In fact they were her favorite children some hundreds of millions of years ago when the coal measures were being laid down in Carboniferous times, and their fossil remains are so characteristic of the Carboniferous strata that the Carboniferous period is frequently referred to as the "age of cockroaches," just as the much later Jurassic period is referred to as the "age of reptiles," etc., from the dominant fauna of the periods in question.

We are accustomed to look upon the hills as "eternal," while the occurrence of so frail a creature as a roach is regarded as merely one of Nature's passing incidents; but, frail as roaches are, the roach type has persisted but little changed from the remote Carboniferous period, while in the meantime, mountian ranges have risen and been leveled again, and the whole face of the landscape has changed, and changed again. During the time in which the roach type has been in existence, the great dinosaurs have come and gone, and birds, mammals, and flowering plants have arisen and developed their myriad profusion; but amid there ceaseless comings and goings, the roach type has pursued the even tenor of its way practically unaffected by the passing of the ages. It is therefore of some interest to study the makeup of an organism so perfectly constructed that it has been able to defy the ravages of time and changing conditions, and the fact that the "changeless conservatism" of roaches has resulted in their retaining many features characteristic of the types ancestral to higher insects, makes their study doubly interesting.

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[1] Contribution from the Entomological Laboratory of the Massachusetts Agricultural College, Amherst, Mass.

In carrying out this study, I had hoped to include all of the main features of the gross external anatomy of the roach in a single paper; but as the work progressed, it soon became apparent that roaches present so many features of morphological interest that it would require too many figures and plates to illustrate the structure of the entire body adequately in a single article. I would therefore present herewith the principal features of the head and abdomen alone, leaving for a subsequent paper the discussion of the thorax and its appendages. The American roach, *Periplanet americana*, was chosen to illustrate the anatomy of a typical roach because of its large size and relative abundance which render it exceptionally suitable for such a study. Specimens preserved in alcohol may be readily obtained from Southern supply houses for approximately five dollars a hundred, and the study of the external anatomy of these insects is well suited to serve as an introduction to the study of the external anatomy of insects in general for students beginning the study of Entomology. A binocular dissecting microscope is absolutely essential for examining the external anatomy of the specimens, which should be studied immersed under alcohol or water, and the field should be illuminated by means of a powerful lamp provided with a bulls-eye condenser.

Seen under the binocular, the head of the roach (Fig. 5) is a beautiful object, "clean-cut," and smoothly polished. The upper lip or labrum *lr* is emarginate anteriorly (i. e. there is a "nick" or emargination *em* in its anterior margin). Behind the labrum is a non-pigmented area *ac* or anteclypeus followed by a more heavily chitinized and pigmented area *eps* called the postclypeus or epistoma. The areas *ac* and *eps* comprise the clypeus, which extends from the labral, or clypeolabral, suture (along which the labrum is hinged the clypeus) to the frontal pits *fp*, which are the external manifestations of certain invginations forming the anterior arms of the tentorium presently to be described. In some insects a clypeal (or clypeofrontal) suture extends from one frontal pit across to the other to demark the posterior limits of the clypeus, but this suture is absent in many Orthopteroid insects. Each postero-latereal angle of the clypeus bears a cup-like depression, the clypeotheca or "precoila" *cth* of Figs. 5 and 4, into which is received an articulatory process of the mandible labelled *g* in Figs. 5 and 4. I formerly (Crampton, 1921) used these points of articulation of the mandibles with the clypeus, as landmarks for demarking the posterior limits of the clypeus; but it is preferable to use the frontal pits *fp* for this purpose, as suggested by Yuasa, 1920.

If we remove the labrum and clypeus and examine their inner or pharyngeal surfaces, the membranous lining is seen to form an area called the epipharynx bearing the labels *pre* and *poe* in Fig. 8. The anterior portion of the epipharynx or preepipharynx *pre* is slightly more pigmented in the median region, and on each side it bears a lateral series of sense organs (only the left hand ones are shown in Fig. 8). The posterior portion of the epipharynx, or postepipharynx *poe* is located in the clypeal region and contains two epipharyngeal sclerites which are somewhat more deeply pigmented than the rest of the membrane of this region. Between the anterior epipharyngeal region in the labium, and the posterior epipharyngeal region in the clypeus, are the tormæ *tor* or thickenings (one on each side) which serve to demark the labium from the clypeus "internally," and are therefore useful land-marks.

Behind the clypeal region *eps* of Fig. 5 is the frontal region or frons *fr*, which is limited anteriorly by the suture (or by an imaginary line when the suture is absent) extending from one frontal pit *fp* across to the other. The frontogenal (suborbital) sutures *fgs* demark the frons from the genæ *ge* postero-laterally, and the anterior arms of the epicraneal suture *frs* demark the frons posteriorly. The epicranial suture is very faint in adult Periplanetas, and is therefore represented by a dotted Y-shaped line in Fig. 5. The arms of the epicranial suture which form the frontal suture *frs* (demarking the frons posteriorly) extend to the clear spaces *ofn* or ocellar fenestræ which contain the lateral ocelli and usually remain clear or colorless when the lateral ocelli become atrophied. The scar-like area or frontal myocicatrix *mc*, near the base of each antenna, is a muscle scar—i. e. it marks the attachment of muscles inserted upon the frons.

Behind the frons *fr* is an area designated as the epicranium, or parietals *pa*, into which the epicranium is divided by the coronal suture *cs* formed by the basal portion of the Y- shaped epicranial suture bearing the labels *cs* and *frs*. The upper (apical) or dorsalmost portion of the head is the vertex—a region not clearly demarked in most insects. The postero-dorasl portion of the head in the region of the occiptial foramen *ocf* of Fig. 11 (i. e. the region bearing the label *oc*) is called the occiput.

The area situated below and behind the compound eye, bearing the label *ge* in Figs. 5 and 11, is called the gena. Its anterior limits are demarked by the frontogenal or suborbital suture *fgs* on each side of the frons, and its posterior limits are demarked by a suture or ridge, the postgenal ridge *por* (Fig. 11) which seperates it from the postgena. The basimandibular suture *bms* of Fig. 5 demarks the gena from the sclerite below it called the basimandibula, mandbiulare, or the triochantin of the mandible—i. e. the area bearing the label *bm* in Fig. 5. Comstock suggests that the region *bm* represents the trochantin of the limb forming the mandible, but the region in question was probably formed by a chitinization of the mandibular membrane between the base of the mandible and the head capsule.

Behind the genæ *ge* of Fig. 11, and seperared from the genæ by the postenal ridges *por* are the postgenæ *pge*, which form the greater portion of the posterior region of the head. A cup-like depression of the postgena, the postgenotheca *pgt* of Figs. 11 and 12, receives a condyle of the mandible labelled *h*. A narrow median area labelled *pes* in Figs. 11, and 12, extends along the vento-median portion of the postgena, in the neighborhood of the mandibles and maxillæ, and the cardo of the maxilla (*cc* of Fig. 2) articulates with its postero-dorsal region. An area called the hypostoma becomes demarked in this region in certain Coleopterous larvæ, etc., but this area is not shown in the roach, nor is there a well defined gular region along which the postgenæ usually extend in Coleoptera and Neuroptera etc.

The chitinized fold-like area labelled *tf* in Figs. 13 and 11 was termed the trophifer by Crampton, 1917, because the labium is borne by it, and the maxillæ are closely associated with it. Yuasa, 1920, calls it the "maxillaria." Holmgren considers that it reppresents the labial segment in embryonic termites. It bears the occipital condyles labeled *x* in Fig. 13, and the cephaligers (*z* of Fig. 13) or head-bearing processes of the lateral cervical sclerites articulate with these condyles. Two occipital tendons *oct* furnish attachment for muscles, as also do the small cervical tendons *y*. The Cushion-like prominences labelled *tpn* in Fig. 13 lie near the gular pits which are the external manifestations of the invaginations forming the posterior arms of the tentorium.

When the mandibles, maxillæ and underlip are removed, and the head capsule is boiled in 10% caustic potash to remove the muscles and other soft parts (which are removed by washing them out with a pipette, of by plucking them away with a fine forceps) one may observe the inner beam-like structures called the tentorium. These structures serve as supports for muscle attachment, for buttressing and strengthening the head capsule, and for holding in place the brain and other delicate structures within the head.

As shown in Fig. 13, the tentorium consists of the following parts. The posterior arms *pot* (called the postentoria, or the "metatentoria" by Yuasa—though the prefix "meta" should be restricted to structures belonging to the metathorax) arise as invaginations of the gular pits *gp* (Fig. 11) situated just beneath the pad-like tentorial prominences labelled *tpn* in Fig. 13; and these invaginations forming the posterior arms of the tentorium unite to form the tentorium proper, or body of the tentorium *etn*, called the eutentorium, or "corpotentorium." An invagination from each of the frontal pits *fp* of Fig. 5 forms one of the anterior arms of the tentorium labelled *ptn* in Fig. 13, and these anterior arms of the tentorium are called the pretentoria. They unite to form a transverse plate labelled *itn*, which is called the intertentorium, laminatentorium, or frontal plate of the tentorium (Comstock & Kochi). Backward prolongations of the structure *itn* extend on each side of the neuroforamen *nf* to connect the plate *itn* with the body of the tentorium *etn*; and the dorsal arms *stn* or surtentoria (supratentoria) extend upward to the region of the antennal sclerite *ban* of Fig. 5. There are thus three pairs of tentorial arms, the anterior arms, *ptn*, the dorsal arms, *stn*, and the posterior arms *pot* shown in Fig. 13; and in the embryo (according to Riley) the posterior arms unite to form the body of the tentorium *etn*, while the anterior arms unite to form the plate *itn*, and they also give off the dorsal arms *stn*, and later become connected with the body of the tentorium *etn*.

The neuroforamen *nf* forms a circular opening through which the crura cerebri pass, and within it may be seen the tentorial tendons by means of which the oesophageal muscles are attached to the tentorium. The plate *itn* is situated between the crura cerebri and the mouth, and upon it are inserted certain muscles, the median tentorial carnia which it bears being apparently developed in connection with this purpose. The body of the tentorium serves to protect the suboesophageal ganglion to some extent, and the nervous system passes below it (i. e. the body of the tentorium) while the gullet passes above it in passing backward into the thorax through the large foramen magnum or occipital foramen *ocf*.

The mouth cavity or pharynx, contains the hypopharynx or lingua, *hph* a tongue-like organ composed of a basal portion, or basilingua labelled *bl* in Fig. 10, and a distal portion of distilingua *dl*. The basal portion is strengthened by the basilingual sclerites, from which a lingualora *ll* or slender lora-like sclerite extends backward to the oesphagus *oes* on each side of the base of the tongue (hypohparynx), while a lingual tendon *lt* serves for the attachment of muscles to the base of the tongue. The distal portion of the tongue is strenghtened by the distilingual sclerites which send down ventro-mesal arms from each side, meeting at the opening of the salivary duct or salivadict *sd*. The salivary glands are paired, and their paired ducts unite to form the common salivaduct *sd* opening at the salivapore which is located below the tongue, in the median line, at its base. The tongue or hypopharynx is provided with taste organs, as are also the epipharyngeal areas in the roof of the pharyngeal cavity and the regions adjacent to the oesophageal opening, etc. The pharyngeal cavity is closed by the labrum and clypeus in front, by the labium in the rear, and by the maxillæ and mandibles on the sides, and it leads into the œsophagus *oes* of Fig. 10 which passes above the tentorial plates *itn* and *etn* of Fig. 13, and out of the head into the neck through the occipital foramen *ocf.*

The mouthparts, as was pointed out a century ago by Savigny, are modified limbs. The mandibles represent the basal segment of a mouth-part-limb (see Crampton, 1921), and their “cutting”or masticatory surface bears the incisors distally—i. e. the tooth-like projections *in* of Figs. 12 and 4, while in the middle of the median or masticatory surface is the mola *mo* or grinding area. Basal to this is the submola or “accia” *smo,* an area lacking in pigment, and clothed with fine hairs in certain insects. The mandible has two “rocking points” or fulcra used as points of support when the muscles attached to the gnathotendons or mandibular tendons *ft* and *et* of Fig. 12 open and shut the mandibles which work with a “sidewise” or “horizontal” movement as they meet under the upper lip *lr* of Fig. 5. Thus, when the muscle attached to the flexor tendon *ft* of Fig. 12 contracts, the mandible rocking on the pivotal point *h* (Fig. 12) on one side, and on the pivotal point *g* (Fig. 4) of the other side is flexed or closed. On the other hand, when the flexing or closing muscles relax, and the opening or extensor muscles attached to the tendon *et* contract, the mandible pivoting upon the same two rocking points, is opened, or extended. The flexor tendon *ft* is borne by a small plate *gn* (Fig. 12) in the medio-basal region of the madible, and the flexor tendon is usually hugely developed to furnish points of attachment for the powerful muscles which close the mandibles in the movements of chewing. Since the opening muscles need not be very powerful, their tendon *et,* which is attached to the protuberance *gpr,* is not very large. Of the two rocking or pivoting points, the posterior or ventral one *h* of Fig. 12 consists of a condyle which is received in a cup or theca *pgt 9* (Fig. 12) at the anterior (ventral) end of the postgena *pge* (compare also Fig. 11). The anterior or dorsal pivoting point of the mandible is a projection labelled *g* in Fig. 4, which is received in a theca *cth* at the postero-lateral angle of the clypeus (compare also Fig. 5). The process *g* of Fig. 4 bears a groove which fits over a ridge or projection of the clypeal angle, and is thus a kind of condyle and cup combined.

The maxilla (Fig. 2) represents a modified mouth part-limb, in which the second and third segments of the limb give off lobe-like processes (or "endites") to form the lacinia and galea, while the so-called endopodite of the limb becomes modified to form the maxillary palpus, as was discussed by Crampton, 1922, and 1923. When the extensor muscles of the maxilla, which are attached to the cardotendon *ct* of Fig. 2. contract, the point *cc* acts as a fulcrum and the maxilla is opened or extended; and when the muscles attached along the sclerite *pas* and to other portions of the maxilla contract, the maxilla is flexed or closed. The basal sclerite *bc* bears a process *cp* to which the tendon *ct* is attached, and from the point *cc*(where the sclerite *bc* of Fig. 2 articulates with the head in the region of the area bearing the label *pge* in Fig. 11) there extends a groove fitting over a ridge on the under side of the head in the neighborhood of the region bearing the label *pge* in Fig. 11. The maxilla, however, has been removed from the left hand side of Fig. 11, and the right hand maxilla dips beneath the region *sm* of the labium, so that the articulating point of the base of the maxilla with the head region is not seen in Fig. 11.

The cardo or basal region of the maxilla is divided into a basicardo *bc* and a disticardo *dc*, as is shown in Fig. 2. The stipes is divided into a true stipes *st* and a narrow median marginal region *pas*, and the muscles attached to this sclerite may have been ressponsible for its demarcation. Internally, there is a parastipital ridge extending along the parastipital suture demarking the sclerite *pas* and there is likewise an internal cardine ridge demarking the sclerite *bc* from the sclerite *dc* in the cardo. A basimaxillary membrane *bm* connects the maxilla with the region in the basal region of the underlip.

The stipes *st* bears a lacinia *la* provided with a fringe of bristles *lf* for sweeping the food into the mouth, or for preventing it from falling out of the mouth during the movements of lacinia. The laciniadentes *ld* (Fig. 2)or tooth-like processes at the apex of the lacinia *la* are probably used in aiding to comminute the food—or to hold the food when it is comminuted ("chewed") by the mandibles. A peculiar appendage *ma* is called the midappendix lacinula, or hamadens, and is present even in such primitive arthropods as the Crustacea. The palpifer *pf* is bent around on the other side of the maxilla, and is therefore not well shown in the view of the maxilla drawn in Fig. 2. The palpifer *pf* is a destinct sclerite in lower insects and bears the galea *ga*, but in the roach the palpifer becomes rather closely united with the stipes *st*, and the stipes appears to bear the galea, although if one examines the other surface of the maxilla, the connection of the basal portion of the galea *bg* with the palpifer *pf* is more readly apparent. The galea *ga* is composed of two segments, the basigalea *bg* and the distigalea *dg*, and the distal segment *dg* forms a sort of hood into which the tip of the lacinia is received. A strengthening rod *gb* (Fig. 3) stiffens the galea on its mesal surface (the one which fits around the tip of the lacinia) and a marginal region *pga* (Figs. 2 and 3) of the galea is clothed with fine hairs. The maxillarypalpus *mp* is borne by the palpifer *pf* and is composed of five segments. The terminal segment is membranous at the tip and is provided with sense organs.

The labium or underlip of the roach articulates posteriorly with the sclerite labelled *tf* in Fig. 11, and the sclerite in question probably represents the dorso-lateral portions of the labial segment, according to the investigations of Holgren, 1909. The basal sclerite *sm* of the labium (Fig. 11) is made up chiefly of the submentum, although its posterior portion may contain the gular region of other insects such as soldier termites, Coleoptera, etc. On the other hand, the gular region may form behind the submentum, and the origin of the gular region is still a matter of doubt. The gular pits *gp* of Fig. 11, which are usaully situated on the gular sutures demarking the gular region laterally, are hidden by the postero-lateral edges of the submentum *sm* in Fig. 11. These gular pits are the external manifestations of the invaginations forming the posterior arms of the tentorioum (Fig. 13 *pot*) as was mentioned above.

In front of the submentum *sm* is the mentum *mn* (Fig. 11), and the entire region in front of the mentum *mn* is referred to as the eulabium, because it is the only part of the underlip formed by the union of the labial appendages in termites, according to Holmgren, who maintains that the mentum and submentum are formed behind the labial segment in the embryo. In front of the mentum *mn* is a small median triangular region *il* or interlabium, and on each side of it are the palpigers *pgr*, which bear the labial palpi *lp*. The palpigers are larger and better developed on the other side of the labium (see Fig. 10, *pgr*). The labiostipes *ls* bear the glossa *gl* and paraglossa *pgl*. When the glossæ and para-glossæ unite to form a single median structure, they are termed the ligula. The labial palpi have a membranous region at the tip of the terminal segment which is supplied with sense organs.

It has long been known that the labium is made up of the union of two appendages like the maxillæ, which are distinct in the embryo; but it is not known what parts of the maxilla correspond to the parts of the labium in every case.. The earlier investigators thought that the cardines (pleural of cardo) unite to form the mentum, while the palpifers form the palpigers, the stipites, (pleural of stipes) form the labio-stipites, the laciniæ form the glossæ, the galeæ form the paraglossæ, and the maxillary palpi form the labial palpi, when the maxilla-like appendages unite to form the labium. The only matter which seems to be in doubt is whether the united cardines form the mentum *mm*, or whether they form the small median region *il* of Fig. 11. I am inclined to think that the small region *il*, rather than the mentum *mn*, represents the united cardines, since Holmgren states the mentum is formed in the embryo *behind* the labial segment, so that the basal segments of the maxilla-like appendages of the labium, which unite to form the underlip can have nothing to do with the mentum, if the latter is formed behind the labial segment. The whole matter is still very puzzling, and should be re-investigated with a view to determining exactly what structures represent the united cardines of the appendages which form the underlip.

Of the other external features of the head which are of any great interest, there remain to be considered only the antennæ. In the roach these are long, slender, delicate, filiform or flagellate structures composed of a great number of segments. At the base of each antenna is a narrow ring-like sclerite *ban* of Figs. 5 and 7, surrounding the antennal membrane at the base of the antenna. This ring-like antennal sclerite is called the basantenna, or antennale. (Yuasa, 1920, uses the form "antennaria," instead of the original form antennale). The basal segment or scape *sc* of Figs. 5 and 7 is borne on a process *af* originally called the antennifer, for which designation Yuasa substitutes the term "antacoila." On each side of the antennifer *af* of Fig. 7 is a small basantennal plate to which is attached a basantennal tendon labelled *tn* in Fig. 9. When the muscles attached to these tendons contract, they move the antennæ, using the tip of the antennifer *af* as a fulcrum, as shown in Fig. 9. Above the base of the antenna is a surantennifer *saf* which connects the base of the antenna above, with the antennal sclerite *ban*, and assists in the complicated movements of the antenna, which is capable of great freedom of movement ,as is necessary in a structure bearing the delicate chemical-sense organs and tactile organs of the "feelers." As is shown in Fig. 7, the scape *sc* articulates with the pedicel *pd* at a point indicated in the drawing, and a similar articulating point is located on the other surface of the antenna. Between these two "rocking points" are small chitinous pedicellar plates embedded in the connecting membrane, furnishing points of attachment for certain of the muscles operating the antennæ. Beyond or distal to the pedicel *pd* is the postpedicel *ppd*, and distal to this are the segments of the flagellum or filament, as the remainder of the antenna is called. The relative sizes of the pedicel, postpedicel etc., vary with the sex of the individual, but these slight sexual differences have not been dealt with in this paper. The flagellum is composed of four principal types of segments. Those in the proximal portion of the antenna are the brachymeres or shorter segments (i. e. *a* and *b* of Fig. 6), while those in the distal portion of the antenna are the dolichomeres or longer segments (i. e. *c* and *d* of Fig. 6). We may further distinguish the short or annular brachymeres *a* from the long brachymeres *b*, and the stout dolichomeres *c* from the slender dolichomeres *d*, though the types merge, and are rather difficult to describe.

Turning next to the consideration of the abdomen: as shown in Fig. 14, there are eight spiracle-bearing segments followed by what appear to be three non-spiracle-bearing segments (the terminal ones) best seen in the dorsal region of the abdomen. The typical segments (in the middle of the abdomen) consist of a dorsal plate of tergite *t* with a lateral subtergite or pleurite *pl* on each side (probably a demarked portion of the tergite proper), and a sternite or ventral plate *s* seperated from the subtergites by a lateral membrane. The spiracles *sp* are borne at the anterior ends of the subtergites *pl,* and if the first segment can be taken as the criterion, the spiracles apparently belong to the antero-lateral area of the tergite which becomes detached to form the subtergite The membranes connecting successive segments are called conjunctiva, and this term is also applied to the membrane connecting the sclerites of the abdominal segments. It is preferable to distinguish the lateral membranes, however, and they are here referred to as the lateral or pleural membranes.

The spiracles are extremely interesting structures, and the first may be taken as an illustration of the way in which a closing appliance was developed to prevent the entrance of deleterious substances. If the first spiracle *sp* (counting from the base of the abdomen) of Fig. 14 is removed with its surrounding body wall, and is examined from within, after removing the soft parts, it may readily be seen that within the atrium or entrance chamber there is a triangular sclerite of suboperculum *sop* of Fig. 19, which was located ventrally when the spiracle was *in situ,* as in Fig. 14, but is apparently dorsal in Fig. 18, which depicts the inner surface when the fragment containing the spiracle is turned over and viewed from within. Certain occlusor muscles such as the one labelled *m* in Fig. 18 are attached to the suboperculum *sop* and extend to the arch or bow *sar* called the spirarcus. When these occlusor muscles contract, the bow *sar,* which pivots at the point *p,* is drawn up against the suboperculum *sop* and effectively closes the entrance to the trachea by pinching the tube together. When the occlusor muscles relax, the elasticity of the parts cause them to spring back, and the trachea is opened again. This is but one more of the marvellous little mechanical devices developed by these interesting creatures, and as one studies their anatomy one's wonder increases that Nature has endowed them with such cleverly efficient mechanisms for carrying on the commonplaces of a cockroach's existence—though I suppose we should naturally expect to find some pretty efficient devices in an organism which has successfully maintained itself for so many million of years despite the vicissitudes of time and changing environment!

The typical tergites and sternites are composed of two principal areas. In the tergite the anterior area (demarked by a transtergal suture or ridge) is the antetergite *at* (Fig. 14) and the posterior region is the tergite proper or eutergite *etg*. Similarly, in the sternal plate there is an antesternite *as* and a sternite proper or eusternite *eus* seperated by a transternal suture or ridge. The antetergite and antesternite are apparently demarked by the friction of the overlapping edges of the telescoping segments, or at any rate, the antetergite and antesternite are usually over-lapped by the posterior portions of the preceding segments and are usually less deeply pigmented than the rest of the tergal and sternal sclerites. The telescoping of the segments of the abdomen allows for distention with eggs, etc., and in its normal state the abdomen of the female is more flattened than is the case with the egg-distended abdomen shown in Fig. 14; and the anterior portions of the sternal and terga are usually hidden in non-distend individuals.

Following the generally accepted usage of systematists, I have restricted the use of the terms tergite, pleurite and sternite to the dorsal, lateral and sternal plates of the abdomen alone, and I would use the designations notum, pleurum and sternum for the parts of the thoracic segments. The segments of the abdomen may be referred to as the uromeres, for the sake of brevity, and counting from the base of the abdomen, I would refer to them as uromere 1, uromere 2, etc., instead of using the longer designation "first abdominal segment, second abdominal segment," etc. The terminal abdominal segments and their various structures are referred to as the terminalia (Crampton, 1918) but Freeborn, 1924, includes in the designation "terminalia" the genital structures as well in higher insects, and the latter usage is preferable in the higher forms where the genitalia and terminal structures are compactly grouped by the shortening and telescoping of the terminal segments of the abdomen. When there is a reduction in the number of the abdominal segments. it is usually the terminal ones which fuse or unite, as is indicated by the fact that the spiracles remain distinct (for the most part) in the basal segments even when the latter become greatly reduced in size.

In Fig. 19, the terminal segments of the abdomen of the female roach are shown more enlarged than in Fig. 14, and uromeres 8, 9, and 10 are shown more in detail, while in Fig. 21 the terminalia of the male are shown more in detail.

The tenth abdominal segment is essentially the same in both sexes, and its sternite is usually reduced or atrophied, while its tergite forms the huge epiproct *ep* or supraanal plate of Figs. 14, 19 and 21. I suspect that the tergite of the eleventh segment unites with that of the tenth to form this large supraanal plate, but the embryologists claim that the eleventh abdominal segment lies behind the plate in question. The epiproct *ep* is divvided into a basepiproct or basal region and a postepiproct or terminal region which becomes divided into two lobes or epiproctal lobes by a deep emargination or epiproctal cleft in its posterior margin. The membranous structure bearing the anal opening posteriorly is the protiger *pro* of Figs. 14, 19 and 21.

In may flies and other primitive insects, the parapodial plates or paraprocts form the basal segment of the cerci; and as was pointed out in a former paper (Crampton, 1921) the paraprocts apparently represent the protopodite of a crustacean limb, in which the endopodite forms the cercus in insects. In the roach, the paraprocts or parapodial plates *par* of Figs. 14, 19 and 21, are large plates situated on each side of the anal opening, and they are divided by a lateral flange, or paracarina, into an upper and lower region. When the gynovalvular membrane, which forms a pouch for carrying the oötheca, becomes distended, as is shown in Fig. 16, it extends dorsalward under the lateral flange of the paraprocts of the female, and this flange thus has an especial use in the female.

At the base of and below the cercus *ce* of Figs. 19, etc., is the basicercus *bce*, which may represent a basal segment of the cercus.

The cercus itself (*ce* of Figs. 14, 21, 24, etc.) is a multiarticulate structure serving as a pair of hinder "antennæ", and is said to bear olfactory organs as well as the tactile organs usually present in the cerci of insects in general. As is shown in Fig. 14, the cercus may be divided by a lateral ridge (cercocarina) into an upper and lower region. The basal segments of the cercus are usually more annular, while the terminal ones are more cylindrical (Fig. 24). In the roach, the cercus migrates from the paraproct *par* (Figl 19) which originally bore it, and becomes secondarily associated with the epiproct *ep*. The cerciger *cg* or process of the epiproct *ep* bears the cercus in such cases, and the surcerciger *scg* forms a second pivotal point in certain of the movements of the cercus.

In handling living roaches, one in made painfully aware of a most nauseating odor which clings to one's fingers even after repeated washing with soap and water. The fluid which produces this odor is probably secreted by the repugnatoria or scent glands labelled *rep* in Fig. 14. These repugnatoria are eversible glands located in the membrane between the fifth and sixth adbominal tergites, and are slightly nearer to the sixth than to the fifth tergite, so that they may possibly belong to the sixth abdominal segment.

The gynomeres, or abdominal segments of the female which become modified to form the secondary sexual characters of the abdominal region, are the seventh, eighth and ninth uromeres. The sternite of the seventh abdominal segment is proudced posteriorly to form the hypogynium *hg* of Fig. 14, which hides the oviositor, and forms the sides and floor of the gynatrium or genital chamber of the female, which receives the parts of the male in copula, and also forms a genital pouch for carrying the ootheca or egg-case which is carried protruding from the end of the abdomen, for a time, before it is deposited. Like the other abdominal sternites, the hypogynium *hg* of Fig. 14, has an anterior region *as* and a posterior region *eus* demarked by a transternal suture or ridge; but in addition to these typical divisions of the sterum, the seventh sternite has a backward projecting structure *gv*, which is divided into two gynovalvæ or pseudo-valves *gv* of Figs. 14, 15, and 16 in the American roach and certain of its allies. The gynovalvular membrane, as shown in Fig. 16, extends between these pseudovalves and upward on each side to the flanges of the paraprocts, to form a pouch for carrying and protecting the ootheca or egg-case, as was mentioned above. When not distended for this purpose, the membrane in question becomes folded between the valves, as in Fig. 26. The endogynal plates *eng* shown in Fig. 26 are probably involved in the stretching of the membrane in question, though it apparently becomes distended and turgid by interal pressure also. At the base of the seventh sternite is the saccopore, or external opening of a ventral bilobed sac, the ventrosacculus *sac*, which apparently serves as a glandular reservoir; and a repellent substance is secreted in it.

When the hypogyium or modified seventh abdominal sternite is removed, as in Fig. 19, the ovipositor or oviscapt with its basal plates etc., is exposed. As may be seen in Fig. 19, the eighth tergite is the dorsal portion of the eighth segment whose ventral parts form the structures labelled *pvu* etc. The sclerites *pvu* normally project backward under the sclerites *vs* and conceal the latter, but in Fig. 19 the structures labelled *pvu* are represented as though forced back and upward in order to show the relation of the parts to one onother. Similarly, in Fig. 20 the sclerites *pvu* are represented as though laid back from the sclerite *vs* which they would normally cover and hide from view. The large cavity within the opening labelled *vul* in Fig. 20, is the uterus and vagina, or common passage of the two oviducts through which the eggs are conducted to the exterior from the ovaries where they are formed. The elongated opening of the vagina, labelled *vul* is the vulva, and the sclerites surrounding it are the perivulva *pvu*. Each half of the perivulva gives off an arm *vbr*, and the two halves are joined by an arch *var*. The walls of the vaginal cavity are membranous, and are thrown into folds in specimens treated with caustic potash. If this condition is normal, it would indicate that the vaginal cavity is capable of considerable dilation at the time of egg-laying, and the character of the perivaginal sclerites would indicate that the vulva might readily be widened considerably to permit the extrusion of a batch of eggs (the eggs apparently are formed at about the same time). If one observes the relation of the sclerite *pvu* to the tergite of the eighth uromere in Fig. 19 (in which the plate in question has been forced back and the parts about it have been evertd) it would appear as though the perivulva *pvu* is a modified portion of the sternum of the eighth uromere. Paytoureau, 1895, however, and recent investigators, such as Chopard, consider that the vagina opens between the seventh and eighth sternites, and in a footnote, Peytourea refers to the observations of Miall and Denny, 1893 on the development of the region in question, in a passage which may be roughly translated as follows: "The delicate indurated membrane which leads out to the vaginal opening is not the eighth sternite, but arises as a fold of the intersegmental membrane." If this is true, it would seem to indicate that the perivulva is a thickening of the intersegmental membrane, rather than a sclerite of the eighth abdominal sternum.

The sclerites immediately behind the plates labelled *vs* in Figs. 20, 19, 17, etc., may represent the structures called the basivalvulæ in other Orthopteroid insects by Crampton, 1917, and Walker, 1919. As may be seen in Fig. 19 the plates *vs* are sclerites of the eighth uromere, and they are connected with the bases of the ovipositor valves *vv*. A small transverse ventral sclerite *ms* situated between the sclerites *vs* of Fig. 20, is considered to be the ninth sternite by Miall and Denny, 1886, although it is not quite clear how they arrived at this conclusion. Its posterior portion surrounds the thecapore *tp* of Fig. 20, or opening of the spermatheca, in which spermatozoa are stored up at the time of mating, to fertilize the eggs. Hence the opening of the spermatheca *tp* of Fig. 20 is normally situated immediately above the vulva *vul* (out of which the eggs pass) when the parts are not unnaturally separated as in Fig. 20. Dr. Walker, however, informs me that this supposed spermatheca is really a gland. The sclerite labelled *ms* in Fig. 17 represents the internal view of the sclerite labelled *ms* in Fig. 20, showing the internal projections of the plate in question.

The ovipositor of the roach is composed of three pairs of valvulæ. Of these, the dorsal valvulæ *dv* and inner valvulæ *iv* (Figs. 20, 17, 19, etc.) belong to the ninth uromere, while the ventral valvulæ *vv* belong to the eighth uromere. The dorsal valvulæ *dv* have been variouly termed the posterior or third gonapophyses, dorsovalvulæ, survalvulæ, nono-valvulæ, etc. The inner ones *iv* have been called the inner or second gonapophyses, intervalvulæ, etc.; and the ventral valvulæ have been called the anterior or first gonapophyses, octovalvulæ, subvalvulæ, ventrovalvulæ, etc.

The sclerite just behind the plate *vs* of Fig. 19 probably represents a modified coxite or protopodite of a limb (of the eighth uromere) in which the outer branch or exopodite was lost and the endopodite or inner branch became modified to form the ventral valve *vv*. The greatly elongated coxite or protopodite of the ninth uromere apparently formed the dorsal valve *dv* whose external branch or exopodite (represented by the stylus in immature roaches) becomes lost in the adult, while the inner branch, or endopodite, becomes modified to form the inner valve *iv*. This is a very complicated idea of the origin of the parts. A simpler view (though one which is less in accord with the facts of comparative anatomy) is that the ventral valves *vv* are merely outgrowths of the eighth uromere, while the dorsal valves *dv* are outgrowths of the ninth uromere, and the inner valvulæ *iv* are outgrowths of the tenth uromere which become secondarily associated with the ninth segment.

Miall and Denny state that "In the cockroach the ovipositor is used to grasp the egg capsule, while it is being formed, filled with eggs, and hardened: and the notched edge is the imprint of the inner posterior gonapophyses, made while the egg capsule is still soft. The shape of the parts in the male and female indicates that the ovipositor is passive in copulation, and is then raised to allow access to the spermatheca." A richly branched valviglandula or valve gland (*vgl* of Fig. 17), which is probably an accessory colleterial gland, pours out its secretion through the valvipore *vpo* (Fig. 20) located between the bases of the inner valvulæ *iv*.

The ninth abdominal segment is the genital segment *par excellence* in the male, and it may be referred to as the andromere. As shown in Fig. 21, its pleurite *pl* is much enlarged and extends downward to the ninth sternite or hypandrium *ha*. The hypandrium *ha* of Fig. 21 consists of a basal portion or hypandrium proper, labelled *eha* and a posterior *scx* formed by the union of the coxites, or stylus-bearing rudimentary abdominal limbs (vestigial protopodites) which unite with a portion of the sternum to form the area labelled *scx* in Figs. 21 and 24, while the styli (vestigial exopodites) remain distinct to form the peg-like appendages *stl* of the ninth sternite in the male. Normally the basal portion to the ninth sternite *eha* of Fig. 21 is overlapped by the eighth sternite and only the portion labelled *scx* projects as in Fig. 24.

Usually the parts of the male genital apparatus are withdrawn, and are concealed by the hypandrium or ninth sternite. At the time of mating, however, they are protruded, and may remain so to some extent even when the male has been killed, as is shown in Figs. 21 and 24—and in some cases the parts are even more protruded than is indicated in the figures in question. When the genitalia are boiled in caustic potash and spread apart, they are seen to consist of the following parts, shown in Figs. 23 and 25. The penis *pe* (Fig. 25) is membranous-walled and is possibly turgid in mating. It is located on the dorsal surface of the penislobus *pel* of Figs. 25, 24 and 23. The ejaculatory duct *ej* of Fig. 25, or common duct from the testes, utriculi, etc. of the male, conducts the genital products to the exterior through the meatus or opening on the side of the penis *pe* (Fig. 25). The walls of the ejaculatory duct are strenghtened by depositions of chitin, and muscles involved in the mating process, are attached to these structures. The glandopore, or opening of the conglobate gland, is indicated by the label *o*, just behind the asperate lobe *asl*, in Fig. 25.

The pseudopenis *psp* of Figs. 21, 23, 24, and 25, serves to introduce the genital products of the male into the parts of the female at the time of mating, and on this account the structure in question has been called the penis by some investigators, but it is not homologue of the true penis (through which the ejaculatory duct empties) of other insects, and on this account it is here designated as the pseudopenis. It bears a lateral papilla labelled *e* in Figs. 25 and 21, and it is possible that a gland may open through this protuberance, although I was unable to find any trace of such a gland in the specimens treated with caustic potash. The process has been called the titillator by Brunner von Wattenwyl, and it has been suggested that it serves to dilate the parts of the female during copula, as may also the bird's-head-shaped, serrate lobe *ser* with its process *fa* (Figs. 25 and 23), although the latter may serve to anchor the parts when the male products are introduced during coitus. The opposing lobes *op* are called claspers by Walker, but nothing definite is known concerning their function, or that of the pointed process *acl* or of the small plate *bu* which bears a short recurved hook-like fold or process. The large supporting arches labelled *ana* and *bar* in Fig. 23 and 25 serve to strengthen the lobes and processes, and also furnish points of attachment for muscles, as do the internal projections and processes labelled *enl* and *epr* in Fig. 25.

The interpretation of the homologies of the above-mentioned parts has not been thoroughly worked out, although Walker, 1922, suggests that the structures labelled *tt*, *ser*, etc., represent the parameres of other insects. Walker, however, applies the designation parameres to entirely different structures in the Apterygota and Pterygota, and different investigators apply the term to so many different structures in different insects, that it is practically impossible to say what is meant by the term parameres. If we restrict the designation parameres to the secondarily-formed outgrowths and chitinizations of the membrane about the intromittent organ, the term parameres might well be applied to the above-mentioned structures in the roach. The lobes *op* etc., of Fig. 25, however, are probably formed in the membrane about the intromittent organ also, and it is necessary to find some other method of differentiating the parameres from the other structures formed in this region. Walker refers to the lobe *pel* as the penis, but I think it is preferable to restrict the designation penis to the structure labelled *pe* in Fig. 25, since I think it very probable that the lobe *pel* corresponds (partly, at any rate) to the chitinized parts about the true penis called the adeagus in other insects. It is quite evident, however, that the whole subject of the homologies of the genitalic parts of male insects should be more throughly studied from the standpoint of comparative anatomy, development, etc., with a view to determing the true interpretation of the parts in these structures which are so much used in systematic entomology.

In the immature roach shown in Fig. 22, the chitinous projections, etc., of the adult insect are not yet developed, and the membranous lobes shown in Fig. 22 represent the undeveloped condition of the more complicated genitalia shown in Fig. 25. In capturing the specimen shown in Fig. 22, the insect was rather tightly squeezed, and the pressure apparently caused the rectum to become everted, exposing the rectal lining and the endorectal plates *enp*, which are rather weakly-pigmented chitinous protections of the rectal folds or bands. The rectum protrudes in a similar fashion in specimens of termites, psocids, etc., preserved in alcohol, and it is possible that the insects in question may be able to protrude the parts voluntarily when irritated by the alcohol into which they are thrown when collected.

In the foregoing discussion, only the external parts of the head and abdomen have been taken up. In a second paper, already practically completed, the external features of the thorax and its appendages will be discussed; and I am hoping to take up the gross internal anatomy as well, in subsequent papers dealing with the structure of the roach *Periplaneta americana*. In the present paper, most of the drawings are based upon a study of P. *americana*; but in a few instances drawings were made from specimens of a closely allied form. The parts of the other forms, however, are so similar to those of P. *americana*, that there will be no difficulty in identifying all of the structures figured, in studying P. *americana*, with the figures in question as a guide.

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## ABBREVIATIONS

| | |
|---|---|
| a | Short antennal brachymeres |
| ac | Anteclypeus |
| acl | Pointed process (acutolobus) |
| af | Antennifer |
| am | Andromembrane |
| ant | Antenna |
| ana | Basal arch (andrarcus) |
| as | Antesternite |
| asl | Asperate lobe (asperolobus) |
| at | Antetergite |
| b | Elongate antennal brachymeres |
| ban | Basantenna |
| bar | Basarcus |
| bat | Basantennal tendons |
| bc | Basicardo |
| bce | Basicercus |
| bg | Basigalea |
| bl | Basilingua |
| bm | Basimandibula |
| bms | Basimandibular suture |

| | |
|---|---|
| bse | Basiserrata |
| bsl | Basilamina |
| bu | Basuncus |
| c | Broad dolichomeres |
| ca | Cardo |
| cc | Cardocondyle |
| ce | Cercus |
| cg | Cerciger |
| cl | Clypeus |
| cm | Basivalvular membrane |
| cp | Cardoprocess |
| cs | Coronal suture |
| ct | Cardotendon |
| cth | Clypeotheca |
| d | Slender dolichomeres |
| dc | Disticardo |
| dg | Distigalea |
| dl | Distilingua |
| dv | Dorsal valvulæ (dorsovalvulæ) |
| e | Pseudopenis papilla |
| eha | Euhypandrium |
| ej | Ejaculatory duct |
| em | Emargination of labium |
| eng | Endogynal plates |
| enl | Endolamina |
| enp | Endorectal plates |
| ent | Endotergite |
| ep | Epiproct or supraanal plate |
| eph | Epipharynx |
| epr | Endoprocessus |
| eps | Epistoma or postclypeus |
| epv | Epivalves |
| et | Extensor gnathotendon |
| etg | Eutergite |
| etn | Body of tentorium (eutentorium) |
| eus | Eusternite |
| ev | Endovalvula |
| fa | Falx or pointed process |
| fgs | Frontogenal suture |
| fp | Fronts pits (frontocavæ) |
| fr | Frons or front |
| frs | Frontal suture |
| ft | Flexor gnathotendon |
| g | Gnathartus (articulatory process) |
| ga | Galea |
| gb | Galeabacillus |
| ge | Gena |
| gf | Galea fossa |
| gl | Glossa |
| gn | Gnathite |
| gp | Gular pits (gulacavæ) |
| gpr | Gnathoprocess |
| gv | Pseudovalves (gynovalvæ) |
| h | Gnathocondyle or hypocondyle |
| ha | Hypandrium (subgenital plate of male) |
| hg | Hypogynium (subgenital plate of female) |
| hph | Hypopharynx or lingua |
| hpl | Hypoplica or endohypandrium |
| hs | Hypandrial suture |
| il | Interlabium |
| in | Incisors |
| int | Intertentorium |
| iv | Inner valves (intervalvulæ) |
| la | Lacinia |
| ld | Laciniadentes |
| lf | Lacinial fringe (laciniafimbrium) |

li.....Labium
ll.....Lingualora
lp....Labial palpus
lr. ...Labrum
ls. ...Labiostipes
lt. ...Linguatendon
m. ...Occlusor muscle
ma...Midappendix
mc...Myociacatrix
md....Mandible
mn...Mentum
mo...Mola
mp...Maxillary palpus
ms...Medisternite
mtn..Metanotum
nf....Neuroforamen
o.....Glandopore
oc....Occiput
ocf...Occipital foramen
oct...Occipital tendons
oes...Oesophagus
ofn...Ocellar fenestræ
op....Opponentes
p.....Pivot of spiracular bow
pa....Parietals (of epicranium)
par...Paraprocts (parapodial plates)
pas...Parastipes
pd....Pedicel
pe....Penis
pel...Penislobus (sublamina)
pes...Peristome
pf....Palpifer
pga...Perigalea
pge....Postgenæ
pgl...Paraglossæ
pgr...Palpiger
pgt...Postgenatheca
pl....Pleurite
poe...Postepipharynx
por...Postgenal ridge
pot...Postentorium
ppd. .Postpedicel
pre...Preepipharynx
pro...Proctiger
psp...Pseudopenis
pt....Pedicel tendons
pvu. .Perivulva
rep...Repugnatoria
s.....Sternite
sac...Ventrosacculus
saf...Surantennifer
sar...Spiracular bow (spirarcus)
sc.....Scape
scg...Surcerciger
scx...United coxites (syncoxite)
sd....Salivaduct
ser...Serrate lobe (serrata)
sm...Submentum
smo..Submola
so....Suboperculum
sp....Spiracles
spt..."Spermatheca" (probably a gland.)
ssa...Subserrata
st....Stipes (eustipes)
stl....Stylus
stn...Surtentorium (supratentorium)
t.....Tergite
tf....Trophifer
tor...Tormæ
tn....Basantennal tendons
tp....Thecapore
tpn...Tentorial prominences
tt....Titillator

| | |
|---|---|
| var | Vulvarcus |
| vbr | Vulvabrachium |
| vf | Valvifer |
| fgl | Valviglandula |
| vju | Valvijugum |
| vl | Valvilora |
| vm | Vulvar membrane |
| vpo | Valvipore |
| vr | Valviramus |
| vs | Valvisternite |
| vul | Vulva |
| vv | Ventral valvulæ (ventrovalvulæ) |
| x | Occipital condyles |
| y | Cervical tendons |
| z | Cephaligers |

## EXPLANATION OF PLATES V, VI, AND VII

Fig. 1. Tendons at base of pedicel of antenna.

Fig. 2. Posterior (ventral) view of dextral maxilla.

Fig. 3. Mesal view of tip of same.

Fig. 4. Anterior (dorsal) view of sinistral mandible.

Fig. 5. Frontal view of head.

Fig. 6. Types of antennal segments.

Fig. 7. Basal region of antenna.

Fig. 8. Inner view of labrum and clypeus.

Fig. 9. Inner view showing tendons at base of antenna.

Fig. 10. View of hypopharynx in relation to upper and lower lip.

Fig. 11. Posterior view of head.

Fig. 12. Posterior (ventral) view of dextral mandible.

Fig. 13. Posterior view of head with mouthparts removed to show tentorium.

Fig. 14. Lateral view of abdomen of female.

Fig. 15. Ventral view of valves at tip of subgenital plate of female.

Fig. 16. Lateral view of same, showing hypogynal membrane.

Fig. 17. Dorsal view of ovipositor and inner view of its basal plates.

Fig. 18. Inner view of first abdominal spiracle.

Fig. 19. Lateral view of segments 8, 9, and 10 of female.

Fig. 20. Ventral view of ovipositor and basal plates.

Fig. 21. Lateral view of segments 9 and 10 of male.

Fig. 22. Ventral view of terminal structures of immature male.

Fig. 23. Ventral view of male genitalia spread apart.

Fig. 24. Ventral view of terminal structures of adult male.

Fig. 25. Dorsal view of male genitalia and subgenital plate seen partially from within.

Fig. 26. Dorsal view of subgenital plate of female, basal portion seen from within.

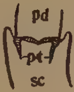
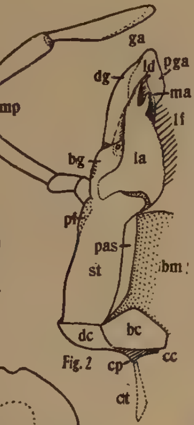


Fig. 1



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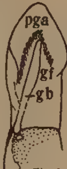

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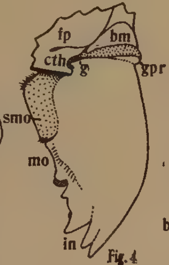

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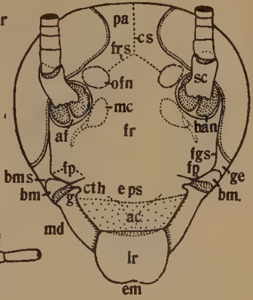

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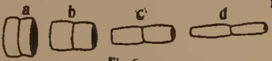

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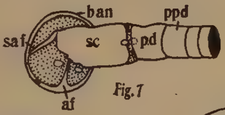

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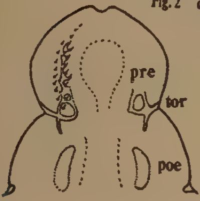

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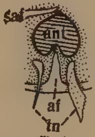

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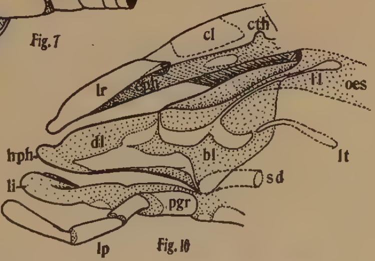

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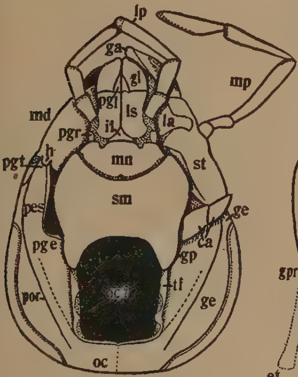

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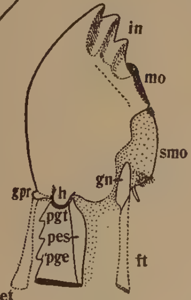

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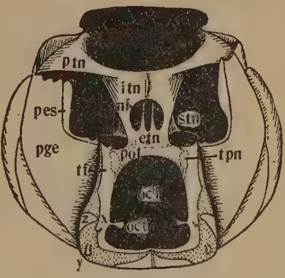


Fig. 13

CRAMPTON—ANATOMY OF THE ROACH

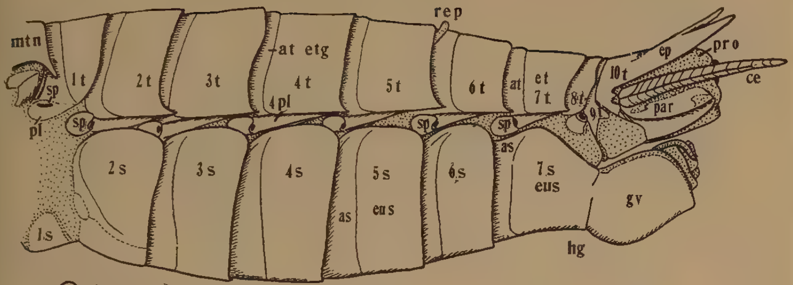
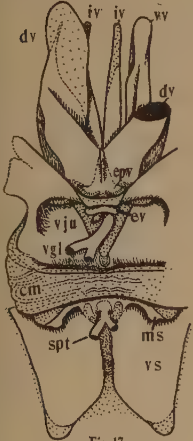


Fig. 14



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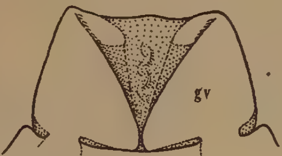
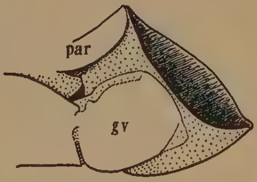


Fig. 15



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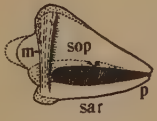

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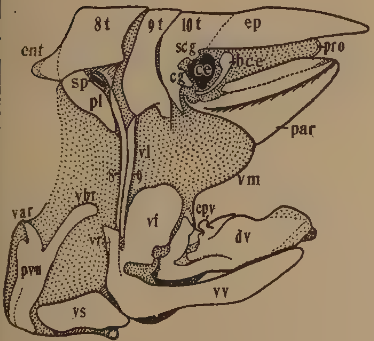


Fig. 19

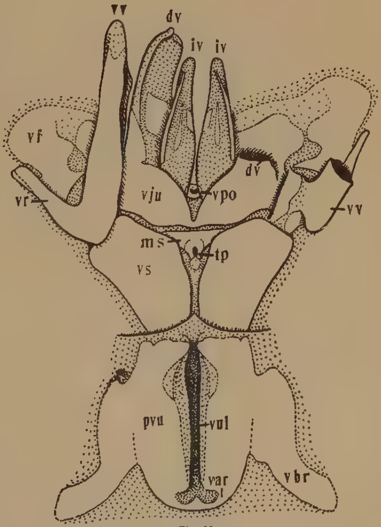


Fig. 20

CRAMPTON—ANATOMY OF THE ROACH

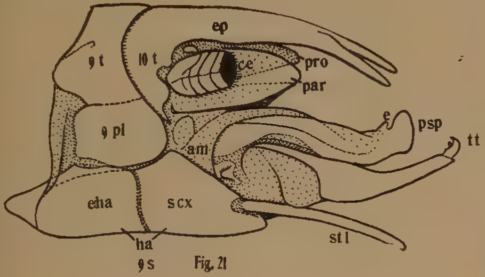


Fig. 21

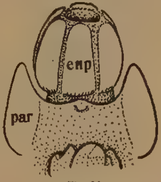
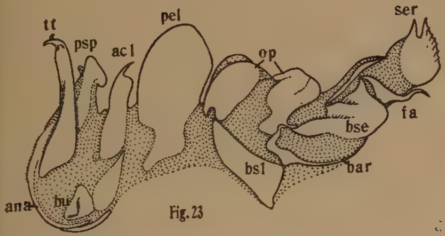


Fig. 22



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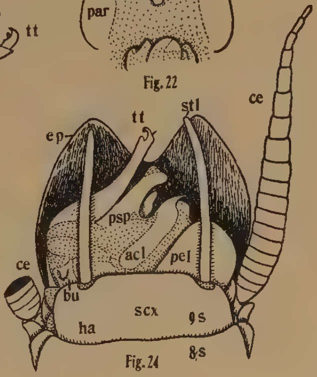

Fig. 24

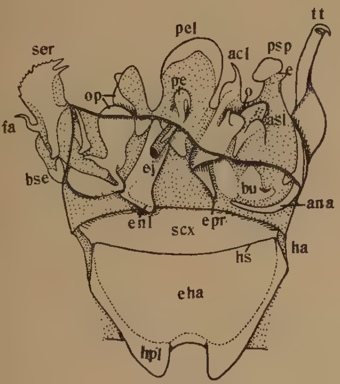

Fig. 25

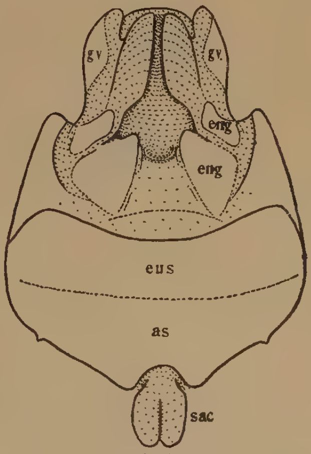

Fig. 26

CRAMPTON—ANATOMY OF THE ROACH

# THE WEIGHT OF VEGETATION TRANSPORTED BY TROPICAL FUNGUS ANTS.

By G. H. Parkar.

Zoological Laboratory, Harvard University.

No one can view a nest of active tropical fungus ants without being impressed by the unusual exhibition of transportation. Converging narrow paths are crowded with myriads of ants many of the incoming members of which carry above their heads the fragments of leaves, bits of stems and the like destined to serve as the soil on which the colony will raise its food. Such a spectacle came to my attention not far from the Barro Colorado Island Laboratory in Gatun Lake, at the Panama Canal. The colony was in an open part of the jungle about a quarter of a mile from the laboratory and easily accessible by a trail. At this laboratory, which is maintained by the Institute for Research in Tropical America, I had the opportunity of studying this and many other features of equatorial life.

The nest was inhabited by the common fungus ant of the region, *Atta columbica* Guér., and comprised an approximately circular area of hummocky soil some twelve to fifteen feet in diameter. Into this area from various parts of the jungle led in all five ant-roads over which varying numbers of ants passed in and out with their burdens. It was comparatively easy to stand at a given point by one of these roads and, with a watch in the hand, count the number of ants with leaf fragments that passed toward the nest in a minute. Twenty such counts were made on each of the five roads.

In the most densely frequented road the numbers of leaf fragments carried past the observer in a minute varied from 151 to 184 and averaged 162.8. In the second most populous road the extremes were 52 and 81 and the average 69. In the third the numbers varied between 49 and 61 and averaged 53; in the fourth the extremes were 1 and 6, and the average 3.2, and in the fifth, which descended from a small tree that rose out of the nest, the numbers varied from 0 to 5, and averaged 2.2. As these five roads were separate pathways leading into the nest, the sum of their several averages, 290.2, represents the total average number of leaf fragments that were brought into the nest each minute.

One hundred of these leaf fragments were taken from the transporting ants and weighed; their weight proved to be 1.164 grams. If on the average a total of 290.2 fragments were carried into the nest each minute, the weight of vegetation added per minute must then have been a little over 3.35 grams. In an hour at this rate it would amount to 201 grams and in twelve hours to a little over 2.4 kilograms or some five and a quarter pounds. I do not know whether these ants work during the night. If they do so even at a lowered speed, the weight of vegetation added per day to the nest must be of course much more than five and a quarter pounds. The records here set down refer to daylight conditions toward the end of June. Incidentally it may be added that the rate of travel of an individual ant carrying a leaf fragment during the warm hours of the day in June varied from 1.5 to 1.2 meters per minute and averaged on ten counts 1.3 meters per minute. These incidental notes seemed worthy of record.

# THE EOCENE FOSSIL FLY EOPHLEBOMYIA.

By T. D. A. Cockarell.

University of Colorado, Boulder, Colo.

In 1922 a remarkable fossil fly, evidently representing an undescribed genus, was found in the Green River Eocene shales near De Beque, Colorado. I described it in Proc. U. S. National Museum, Vol. 64, Art. 13, p. 4 (1924) as *Eophlebomyia claripennis*, with an enlarged figure from a photograph by Dr. R. S. Bassler. With hesitation, I placed it in the Trypetidæ, remarking: "I at first thought to refer it to the Anthomyiidæ, but it appears to be acalyptrate, and the venation agrees better with Trypetidæ. In certain respects, it agrees with what we should expect to find in an ancestor of the modern Trypetidæ." Some time after, I found I had a second specimen from the same region, and this I sent to the British Museum. I was particularly anxious for Major E. E. Austen to examine it, because the fly, as I had stated in my description, resembled *Glossina* in the course of the fourth longitudinal vein. In his Handbook of the Tsetse-flies, Austen called attention to this character in *Glossina* as something absolutely unique.

Major Austen very kindly examined the fossil at once, and wrote at length concerning it. I urged him to publish an article, but he asked me to do whatever seemed necessary, giving full permission to quote his opinions. I meant to wait until again publishing on Eocene insects, but as such publication may not occur for a long while, it seems best to offer the present discussion. Major Austen wrote (Dec. 13, 1924):

"After making as careful an examination of the specimen as I can, I am inclined to doubt whether the species belongs to the Acalyptratæ at all. I certainly can't distinguish any squamæ, but that doesn't prove the absence of these structures. In spite of the Trypetid-like character of the auxiliary vein, the extreme shortness of the anterior transverse vein, coupled with the apparent absence of bristles on the extensor surface of the tibiæ, in my opinion renders the inclusion of the species in the family Trypetidæ impossible. The short anterior transverse vein is characteristic of the Calyptrate, not of the Acalyptrate Muscoidea; but although the open first posterior cell would seem to suggest that the species should be referred to the Anthomyiidæ, I don't think that strictly speaking it can belong to this family, owing to its smooth tibiæ. On the other hand, the *Glossina*-like course of the fourth longitudinal vein, to which you draw attention in your description of the genus *Eophlebomyia*, is very remarkable, and may be significant. Unfortunately, since nothing can be seen of the proboscis or arista, it is impossible to determine whether or not the fly should be regarded as a blood-sucker. Be this as it may, I am, for the moment at any rate, inclined to consider *Eophlebomyia* as possibly representing an annectant form between the Anthomyiidæ and the blood-sucking Muscidæ, as represented by *Glossina*."

With regard to the tibiæ, in the original type, now in the U. S. National Museum, it was possible to see that there were no preapical bristles, but were minute dark hairs on outer side arranged in two lines.

In a later letter, Major Austen discusses the question whether *Glossina* may have originated in America, and spread later to Africa. We have of course, severals species of *Glossina* in the Colorado (Florissant) Miocene; and it is at least conceivable that the Eocene *Eophlebomyia*, from the same general region, may be ancestral to them. In this case, it appears to follow that the so-called Muscidæ are polyphyletic, the *Glossina* group having arisen independently from the others. *Eophlebomyia* is best placed in a separate family, *Eophlebomyiidae.*

It is a pity that more collecting is not done in the Eocene shales of the Roan mountains and adjacent ranges. The many excavations in the oil shales have resulted in throwing out and exposing large quantities of rock, which should be searched for fossil insects and plants. In a few years weathering will have decayed and spoiled these precious materials. The cost of an expedition, as such things go, would be very small. The best time would be in the fall. The discovery of such a fossil as *Eophlebomyia* is certainly worth the time, trouble and expense.

# THE INSECTS AND PLANTS OF A STRIP OF NEW JERSEY COAST[1]

By Harry B. Weiss and Erdman West

New Brunswick, N. J.

## *Introduction.*

This paper deals with the insects and plants of a section of the maritime region of New Jersey and is the fourth of a series of reports on surveys which have been made in different faunal areas of New Jersey.

## *Acknowledgments.*

Identification of the various species of insects collected during the survey were made by the following entomologists to whom we are greatly indebted. Hymenoptera, Mr. H. L. Viereck; Diptera, Mr. C. W. Johnson; Coleoptera, Mr. C. A. Frost; Hemiptera, Mr. H. G. Barber; Lepidoptera, Mr. Carl Heinrich and Mr. Wm. Schaus; Cicadellidæ, Mr. C. E. Olsen; Formicidæ, Mr. M. R. Smith; Odonata, Mr. Wm. T. Davis; Orthoptera, Dr. Henry Fox.

## *The New Jersey Sea Coast*

The maritime region of New Jersey extends along the coast from Sandy Hook to Cape May and includes the beach and its adjoining sand hills. The beaches are narrow, sandy strips often separated from each other by inlets and from the upland by bays, and channels fringed by tide-marsh or salt meadow. According to the "Annual Report of the State Geologist of New Jersey" for 1885, the beaches "are sand bars of considerable magnitude, which have been formed at a greater or less depth by currents depositing sediment under favorable conditions and subsequently brought above water by the waves, as at the present day, or perhaps in some cases by the changes of sea level which have evidently occurred in Quarternary time." Once above water, the particles of sand are carried by the wind and meeting some obstacle out of reach of the tide, are in time built up into dunes or sand hills. After the primary beaches are formed, various agencies combine to change their original extent. "On one side they might be worn away by storms and tidal currents, on another added to by the same agencies and finally they might be greatly extended in course of time by the action of currents running in a constant direction along their shores and depositing sediment at one of their extremeties, as happens now at the point of Sandy Hook, and the south ends of most of the beaches at the inlets."

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[1] Journal New York Entomological Society, vol. xxx, pp. 169-190; Journal New York Entomological Society, vol. xxxii, pp. 93-103; Ecology, vol. v, pp. 241-253.

The beach islands consist of fine white sand which is mobile in places. Dried by the sun and wind, the sand is blown inward or oceanward. The prevailing winds blow toward the ocean and as the sand dries it is blown into the water to be hurled back again by the waves. If the wind is from the ocean for some time, sand hills are formed. Small obstacles sufficient to lessen the force of the wind may serve as the starting point of a dune. Such dunes may form and reform with every action of the wind. At Seaside Park, the shifting was quite pronounced and the contour of the line of dunes next to the ocean changed frequently.

Behind the ocean line of dunes, the shapes of the smaller dunes changed infrequently or not at all. Where vegetation occurs on the beaches such plants catch and hold the sand and dunes are formed rapidly. The beaches vary in width from a few rods to a half-mile and in elevation average only a few feet above high tide. The dunes formed by winds and tides generally reach a height of from fifteen to twenty-five feet.

## *The Surveyed Area.*

The surveyed area consists of about ten acres in the form of a strip running from the Atlantic Ocean to Barnegat Bay, across Island Beach at a point about one mile below Seaside Park, and just above the Island Beach Life Saving Station. The exact location is indicated on the accompanying map. Temperature and moisture records were not kept, but climatological data for the coastal section in which the survey was made, can be obtained from the publication of the United States Weather Bureau, entitled "Summary of the Climatological Data for the United States by Sections," Reprint of Section 99, The Southern Interior and Sea Coast of New Jersey.

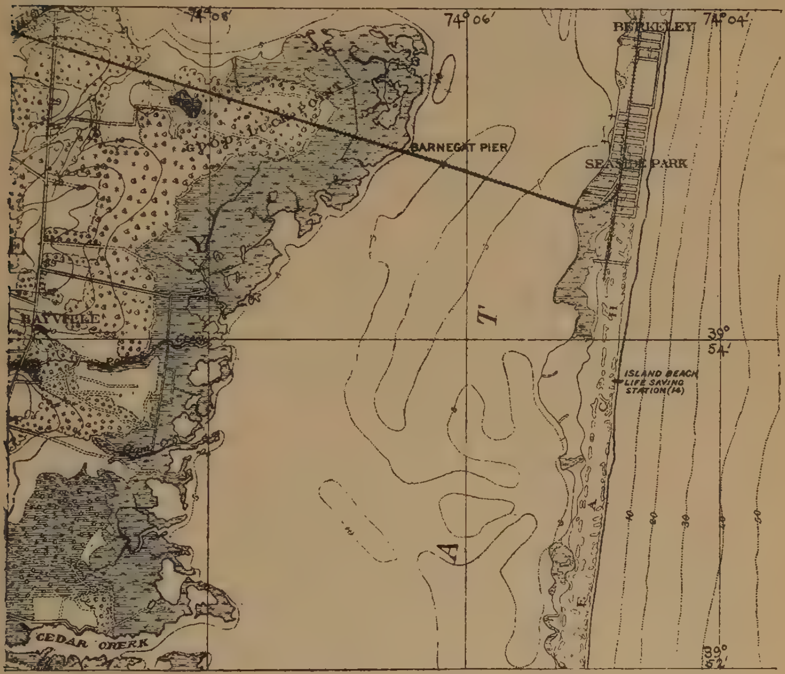

Fig. 1. Map of a portion of the New Jersey coast. The surveyed area adjoins the Island Beach Life Saving Station.

Island Beach from Seaside Park south to Barnegat Inlet is almost the only piece of natural beach left along the New Jersey coast. On account of the absence of a roadway, it has remained "undeveloped" and as such is free from bungalows, cottages, cement walks, real estate agents, swarms of bathers and the amusements supplemental thereto. It is probably only a question of time before it will be levelled, graded and cut up into building lots.

Collections were made at about ten-day intervals from the very beginning to the end of the insect seasons. All methods were employed and everything was collected. Some night collecting was done also. The area under consideration contained several shallow basins and wet places due to arms of the bay which extended toward the Atlantic Ocean, but little attention was paid to these areas and their comparatively luxurient vegetation, as it was thought desirable to limit the study to the strictly sea coast type. Insects found in "wash-up" along the shore, although collected, are not included in this report unless they are species which normally inhabit the beach and act as scavengers or in other capacities.

Although the flora of the area can be divided into parallel zones, it is necessary to consider the insects as a single group, partly on account of the comparative smallness of the surveyed territory and partly because many species exhibited no tendency to connect themselves exclusively with certain types of vegetation. Species constantly inhabiting various parts of the area will be mentioned in the text.

## *The Vegetation of the Surveyed Area.*

The flora of this area is divided more or less distinctly into bands or zones parallelling the ocean and bay shore lines. The best way to discuss the vegetation is to take each of these groups in order as they occur, beginning at the ocean shore line. As no collections were made in the water, the only clue we had to the algæ present was the remnant in the wash. This consisted almost entirely of sea lettuce (*Ulva* sp.) and a brown strap-like kelp. From the edge of the water to the base of the dunes, the sand was devoid of plant life, but about one-half way up the dunes, there appeared an occasional plant of seaside spurge (*Euphorbia polygonifolia*).

The outer row of sand dunes had a distinct and characteristic vegetation. The sea sand reed (*Ammophila arenaria*) was the most important and abundant plant and its persistence and habit of growth enabled it to successfully combat the shifting sands of the dunes. It gave the first tinge of green to this region in spring and its lines of sprouts from the underlying roots broke the force of the winter winds and prevented the sand from drifting to any great extent. Totally different in appearance from the grass, another plant, the seaside golden-rod (*Solidago sempervirens*) was second in importance. All during the summer months, the large tufts of fleshy leaves were very conspicuous and later the heavy sprays of yellow blossoms were quite showy. Scattered all through the vegetation created by the previous plants we found the little sand hugging sea spurge. On the bay side of the dunes there were occasional patches of beach pea (*Lathryrus maritimus*). This plant constituted a prominent element with its tangled stems, bright flowers and noisy pods.

On the area between the first line of dunes and the margin of the dune formation there were a number of important groups. In the first one large masses of bayberry (*Myrica carolinensis*) occurred at regular intervals with occasional plants almost at the foot of the first line dunes. Another important shrub mixed with the bayberry was beach plum (*Prunus maritima*). Its dense masses of white flowers were very showy in the spring. The fruiting propensities of the plant however, were variable, some were loaded with plums and others bore but few. Little of the fruit ripened as people were well acquainted with its value in making jam and jelly.

Other larger areas were inhabited extensively by beach heather (*Hudsonia tomentosa*). Dull and inconspicuous throughout most of the year, it stood out in strong contrast to the sand when it was covered with yellow flowers in the spring. In this group there were also frequent plants of beach pin weed (*Lechea maritima*) and patches of sea coast joint weed (*Polygonella articulata:*, the latter being much more numerous than conspicuous. The cactus (*Opuntia opuntia*) occurred here, sometimes forming plants three feet across. In this band was found the only fungus of noticeable importance in the whole area. This was the earth star (*Geaster* sp.) which appeared late in the summer in sheltered sandy places where other vegetation was scanty or lacking. In the deep sand only the spongy, spore bearing portion was pushed above the surface of the sand by the hygroscopic action of the reflexed peridermium.

The third important group in this section was found in the low, wet spots in which no collecting for insects was done. These low spots were almost impenetrable thickets of green brier (*Smilax rotundifolia*), tall blackberry (*Rubus argutus*), poison ivy and glossy rose (*Rosa virginiana*). With these there was a generous sprinkling of sheep laurel (*Kalmia angustifolia*),

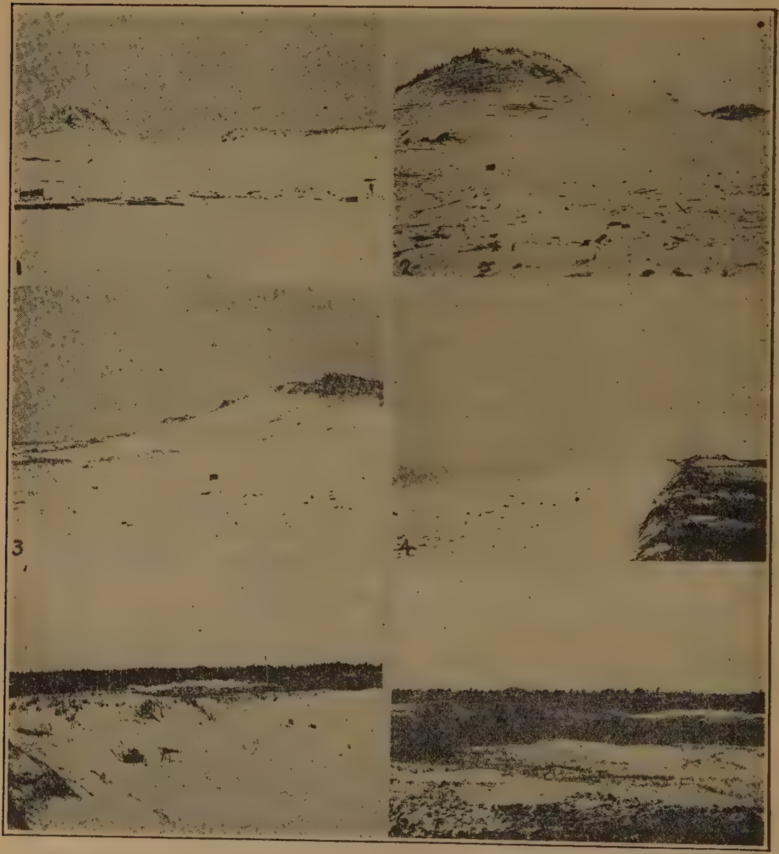

Fig. 2. Views of the surveyed area. 1, 2, 3, 4, views along the seashore showing the dunes and their sparse vegetation. 4, 5, views looking across the surveyed area showing the low vegetation and the many, open, sandy areas.

tall blueberry (*Vaccinium corymbosum*), bayberry (*Myrica carolinense*) and scrubby red cedar (*Juniperus virginiana*).

From the edge of the dune formation to the bay shore, the vegetation was quite uniform. A major portion of the area which comprised all of the high sandy ground on which the collecting was done, was covered with beach heather. As near the dunes, *Lechea maritima* was occasional here. A few patches of blue toad flax (*Linaria canadensis*) were found here in spots with the most underground moisture.

As the bay shore was approached this *Hudsonia* flora was diluted with various grasses in increasing amounts until it disappeared and a new type of vegetation took its place. In the beginning this transition was slow but close to the bay shore the change was rapid and other species came in. Some of the plants in this last area were undoubtedly "ballast plants." The beach goldenrod reappeared here in great profusion but due to severe insect attacks, it did not bloom freely. Wild pepper grass (*Lepidium virginicum*), sheep sorrel (*Rumex acetosella*), sea burdock (*Xanthium canadense*), goose foot (*Chenopodium polyspermum*), beggar ticks (*Bidens connata*), salt marsh fleabane (*Pluchea camphorata*), bush goldenrod (*Euthamia graminifolia*) and primrose (*Oenothera biennis*) more or less evenly mixed made up the major portion of the dry ground flora close to the bay shore. In addition there were a few patches of great bind weed (*Convolvulus sepium*) with its showy pink flowers. In the moist spots there were a few bushes of marsh elder (*Iva fructescens*) and speckled alder (*Alnus incana*).

In the lower portions of this area we found the same group of marsh loving plants as near the ocean shore but with some additions. There were also several small, wild cranberry bogs (*Oxycoccus marcocarpus*). In other spots there were patches of the sundews " *Drosera rotundifolia* and *Drosera filiformis*. *Lycopodium chapmani* was quite frequent in wet spots. The narrow leaved sundrop (*Kneiffia linearis*) was most plentiful along the margins of these moist areas.

## *The Insects of the Surveyed Area.*[1]

Neuroptera: Chrysopidæ 1, Myrmeleonidæ 1, Total 2.

Isoptera: Termitidæ 1, Total 1.

Odonata: Agrionidæ 1, Libellulidæ 1, Total 2.

Thysanoptera: Thripidæ 1, Total 1.

Homoptera: Aphididæ 2, Membracidæ 2, Fulgoridæ 6, Cercopidæ 2, Tettigoniellidæ 4, Cicadellidæ 13, Total 29.

Hemiptera: Pentatomidæ 6, Lygæidæ 12, Coreidæ 3, Tingitidæ 1, Reduviidæ 2, Phymatidæ 1, Anthocoridæ 1, Miridæ 8, Ochteridæ 2, Total 36.

Orthoptera: Acridiidæ 10, Locustidæ 4, Gryllidæ 3, Total 17.

Coleoptera: Cicindellidæ 2, Carabidæ 7, Silphidæ 1, Staphylinidæ 7, Phalacridæ 2, Coccinellidæ 7, Dermestidæ 2, Histeridæ 7, Nitidulidæ 1, Latridiidæ 2, Dascyllidæ 1, Elateridæ 4, Buprestidæ 2, Lampyridæ 3, Malachidæ 2, Cleridæ 1, Scarabaeidæ 4, Cerambycidæ 3, Chrysomelidæ 19, Mylabridæ 1, Tenebrionidæ 6, Melandryidæ 1, Mordellidæ 2, Anthicidæ 1, Meloidæ 1, Thynchitidæ 1, Otiorynchidæ 1, Curculionidæ 7, Calandridæ 2, Anthribidæ 1, Total 101.

Lepidoptera: Nymphalidæ 5, Lycaenidæ 2, Pieridæ 3, Hesperidæ 1, Syntomidæ 2, Arctiidæ 1, Noctuidæ 12, Hypenidæ 1, Geometridæ 1, Pyralidæ 5, Oecophoridæ 1, Blastobasidæ 1, Total 45.

Hymenoptera: Tenthredinidæ 1, Vipionidæ 9, Braconidæ 6, Ichneumonidæ 18, Cynipidæ 2, Pteromalidæ 1, Callimonidæ 1, Eurytomidæ 1, Chalcididæ 2, Platygastridæ 1, Bethylidæ 1, Mutillidæ 1, Psammocharidæ 5, Vespidæ 1, Sphecidæ 3, Bembecidæ 2, Apoidea 4, Nomalidæ 1, Hylaeidæ 1, Anthophoridæ 1, Colletidæ 3, Xylocopidæ 1, Ceratinidæ 2, Apidæ 3, Formicidæ 23, Total 96.

Diptera: Tipulidæ 4, Chironomidæ 6, Culicidæ 2, Mycetophilidæ 1, Cecidomyiidæ 1, Bibionidæ 4, Tabanidæ 3, Bombyliidæ 1, Therevidæ 3, Asilidæ 3, Dolichopodidæ 4, Empididæ 5, Lonchopteridæ 1, Pipunculidæ 2, Syrphidæ 6, Conopidæ 1, Tachinidæ 1, Sarcophagidæ 2, Muscidæ 3, Anthomyidæ 9, Borboridæ 1, Sapromyzidae 6, Micropezidæ 1, Trypetidæ 1, Sepsidæ

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[1] Numbers following family names indicate number of species collected.

1, Ephydridæ 3, Oscinidæ 10, Drosophilidæ 1, Agromyzidæ 5, Total 93.

### *Notes on Certain Species of Insects.*

*Neuroptera.* The two species in this order were *Brachynemurus abdominalis* Say, which was common (8-5; 10-24; 11-8) and *Chrysopa oculata* Say (6-16; 8-20).

*Isoptera.* *Termes flavipes* Koll. was found early in the season (5-15) in rotten wood and wingless termintes (5-29) at the water line of the ocean.

*Odonata* *Erythrodiplax berenice* Dru. was common along the shore (7-15; 8-5) and also *Enallagma durum* Hagen (7-15; 8-5; 9-8; 9-26) the larvæ of the former living in salt water according to Smith.

*Homoptera* Plant lice were observed on seaside goldenrod and *Lactua* sp. Aside from *Phlepsius fascipennis* Van D., which occurs on salt marshes and which was collected July 15, nothing unusual or characteristic of the locality was observed. Several species which do not appear to have been previously recorded from New Jersey were collected and these are as folflws, *Cixius basalis* Van D. (7-15), *Myndus fulvus* Osb. (7-15)., *Megamelanus elongatus* Ball (6-16), *Bostæra nasuta* Ball (8-5). *Platymetopius cuprescens* Osb. (8-20, 9-26), *Thamnotettix nigrifrons* (Forbes) (6-16, 7-15, 10-24).

*Hemiptera.* The Pentatomidæ, Lygaeidæ and Miridæ were the best represented families. In the Pentatomidæ, *Aethus obliquus* Uhl. was found May 7 in the sand under *Hudsonia* and *Thyanta custator* Fab. was plentiful from May to September. In the *Lygaeidæ*, *Orthlomus ocolopa* Uhl was collected (7-15, 9-26 and *Blissus leucopterus* var. *arenarius* Barb. (5-7, 7-15-9-26. In the Coreidæ, *Harmostes reflexulus* Say and *Corizus lateralis* Say were plentiful throughout the season. *Corythucha marmorata* Uhl. was noted on seaside goldenrod and this nearness to the ocean may explain its occasional presence in "wash up." *Tetraleps insidiosus* (Say) was swept from beach pea by the thousands during September and *Ochterus banksi* Barb. which appears to like the seashore was collected on July 2.

*Orthoptera.* In this order *Trimerotropis maritima* (Harris) which is almost exclusively a beach species was plentiful from the middle of July to the end of October. *Psinidia fenestralis* (Serv.) was plentiful in the area from August 5 to September 26 as was *Melanoplus femur-rubrum* from the first week of September to the end of October. In the Gryllidæ, *Gryllus assimilis* Fab. form *luctuosus* Serv. was taken in various parts of the area except the seashore from May 7 to the last week of October, and was present in large numbers under a dead horse-shoe crab along the bay shore. *Oecanthus quadripunctatus* Beut. was numerous from August 8 to September 26 and occurred plentifully on seaside golden rod flowers on the latter date.

*Coleoptera.* *Cicindela dorsalis* Say, a seashore species was collected (7-15) on the beach. Other species taken on the beach were *Pasimachus sublævis* Beauv. (5-7), *Panagæus crucigerus* Say (7-15), *Pinacodera limbata* Dej. (7-15), *Anisodactylus rusticus* Say (5-7 to 10-24) along the seashore and also in sand under *Hudsonia* during the early portion of the season. All of the foregoing are members of the Carabidæ. *Silpha surinamensis* Fab. was collected under a dead horse-shoe crab on August 5 as were also *Creophilus villosus* Grav. and *Tympanophorus puncticollis* Er. *Staphylinus prælongus* Mann was found along the seashore together with *Diochus thoracicus* Csy. on June 16. Seven species of Coccinellidæ were present in the parts of the area covered by vegetation. *Dermestes caninus* Germ. was collected under a dead horse-shoe crab on August 5 along the shore and in other parts of the area on September 8. *Dermestes frischi* was found along the shore on May 29. In the Histeridæ, *Saprinus fraternus* Say which occurs throughout the state was found along the ocean front (5-29, 7-2); *Saprinus pennsylvanicus* occured under a dead horse-shoe crab (8-5) together with *Hister abbreviatus* Fab. *Hister arcuatus* Say was collected along the shore (7-2), *Saprinus mancus* Say in sand under *Hudsonia* (5-7) and *Hister obtusatus* Harris along shore (6-16). Other species found along the seashore were *Polyphylla variolosa* Hentz (7-15), *Collops nigriceps* Say (7-2), *Monoxia puncticollis* Say (7-2), *Epitragus arundinis* Lec. (8-5, 8-20), *Ephalus latimanus* Lec. (5-7, 6-15), *Phaleria testacea* Say (5-29, 7-15), and *Sphenophorus venatus* Say (9-8).

*Galerucella kalmiæ* Fall was collected under seaweed along the bayshore (5-29) and along the seashore (6-15). *Trirrhabda virgata* Lec. was noted seriously injuring the leaves of seaside goldenrod and marsh elder, being present from July 2 to September 26. *Stratægus antæus* came to our bait of molasses and fusel oil on the night of September 1 and previous to this time, many dead specimens were noticed in various parts of the area.

*Lepidoptera.* Many interesting species were observed, the most common being *Nomophila noctuella* D. & S. (5-29 to 10-24), *Syneda graphica* (5-7 to 8-20), *Ommatostola lintneri* Grt. visiting goldenrod flowers (9-26), *Euxoa detersa* Wlk. very common on goldenrod flowers (9-26), *Pieris rapæ* which was plentiful along the bay shore (7-15 to 9-26), and *Heodes hypophleas* Boisd. which occurred from May 7 to May 29.

*Hymenoptera.* As most of our Hymenoptera were not identified beyond genera, it is impossible to mention more than a few of the outstanding species. Galls of *Solenozopheria vaccinii* were present on blueberry stems. *Psammochares philadelphicus* Le P. was collected along the seashore (7-15) and in other sections (7-20, 8-20). *Pompiloides marginatus* Say occurred along shore (9-26) and in other areas (7-15, 8-20). *Polistes pallipes* Le P. was taken from May 15 to October 24 and *Colletes americanus* Cress. was plentiful on goldenrod flowers (9-26). *Bremus bimaculatus* Cress. was noted visiting beach pea flowers on June 16. Among the ants *Dolichoderus plagiatus pustulatus* Mayr. var. *beutenmuelleri* Wheeler. *Formica pallide-fulva schaufussi* Mayr var. *incerta* Emery and *Lasius niger* Linn. var. *neoniger* Emery were common throughout the season. *Camponotus caryæ* Fitch was collected May 29 from an old cone of *Pinus rigida* where it appeared to be nesting.

*Diptera.* Some ninety-three species were collected, many of which it is impossible to mention on account of a lack of space. The following species were collected along the seashore.

*Tipula perlongipes* Johnson (7-15), *Neopogon argenteus* Say a sand dune species (8-5), *Villa shawi* John. (9-26, 10-24), *Psilocephala morata* Coq. (6-16), *Coloboneura inusitata* Mel. (7-2).

*Fucellia maritima* Hal. was plentiful both on the seashore and the bayshore from April 17 to October 24. *Sarcophaga pachyprocta* Parker was plentiful in the area at all times and was bred from puparia collected on the surface of the sand between the sand dunes. Other species plentiful in other parts of the area were *Bibio albipennis* Say (5-15, 5-29), *Epomyia rufiventris* Loew (7-15, 9-8), *Cœnosia nudiseta* Stein (6-16 to 9-26), *Scatella lugens* Lw. (5-7 to 7-15), *Hippelates subvittatus* Mall. (6-16 to 9-26), *Botanobia frit* Linn. *Rhicnœssa parvula* Loew (5-29 to 7-2), and *Toxomerus marginatus* Say 6-16 to 10-24). Visiting goldenrod flowers on September 26 and present at previous times were *Stomoxys calcitrans* Lw. *Phormia regina* Meigen, *Eristalis æneus* Scop. and *Eristalis transversus* Wied. Early in the season land breezes brought *Aedes cantator* Coq. and later *Aedes sollicitans* Wlk.

## SUMMARY.

*Insects of the Coast.*

| Order | Number of Species | Percent of total |
|---|---|---|
| Neuroptera | 2 | 1 |
| Isoptera | 1 | |
| Odonata | 2 | |
| Thysanoptera | 1 | |
| Homoptera | 29 | 7 |
| Hemiptera | 36 | 8 |
| Orthoptera | 17 | 4 |
| Coleoptera | 101 | 24 |
| Lepidoptera | 45 | 11 |
| Hymenoptera | 96 | 23 |
| Diptera | 93 | 22 |
| | 423 | 100 |

*Types of Food Habits*

| | Number of Species | Per cent of total |
|---|---|---|
| Phytophagous | 189 | 45 |
| Saprophagous | 110 | 26 |
| Harpactophagous | 58 | 14 |
| Parasitic | 47 | 11 |
| Pollen feeders, misc. spp. | 19 | 4 |
| | 423 | 100 |

As indicated above, with respect to the number of species, the Coleoptera, Hymenoptera and Diptera each supplied an almost equal amount and these orders are followed in turn by the Lepidoptera, Hemiptera, Homoptera and Orthoptera. Concerning the types of food habits, these being based for the most part on the predominating larval habits of the families regardless of numerical abundance (and with the disadvantages of this method fully in mind) 45 per cent of the species present can be classed as phytophagous, 26 per cent saprophagous, 14 percent harpactophagous and 11 per cent parasitic and it is assumed that similar ratios will be found in other coast sections where similar conditions prevail.

# NOTES ON GALERUCINÆ IN MY COLLECTION.

By F. C. Bowditch,

Brookline, Mass.

In bringing my material in line with the new catalogue of Galerucinæ by Weise, I have run against many troubles. In the new list are many typographical omissions and mistakes and very many species omitted altogether (these will shortly be treated in a separate paper by M. Laboissiere). Possibly the state of Mr. Weise's health prevented the proper finishing touches. The catalogue revision was a big job but it lacks finish to make it reliable; and then, what to me is a serious drawback, the paper it is printed upon (my copy at least) does not admit of notations in ink.

## **Oides niasensis** sp. nov.

Large sized, honey yellow with black elytral spots, elytra with 4 round sub basal spots 2 on each side, subhumeral and almost submedian, four large rounded and median, joined in pairs (dumb-bell shaped) not attaining either the edge or suture, and lastly a small round ante apical, sides of the breast and abdomen spotted with black.

Types of 2♂ 2 ♀ Lahago Central neas 4-11-10-111 1896 12 Kannegieter length 10-11 mm. Bow Coll.

Head smooth with impressed line on vertex, antennæ about half as long as body entirely yellow, joint 3-5 about equal, clypeus swollen and smooth, thorax evenly rounded, impunctate and without a definite depressions (1 example with 2 small brown submedian spots) elytra thickly and rather coarsely punctate without transverse depression but with rather a deep subhumeral; what I take to be the ♀ has rather a pear shaped form with the dilation at the rear; ♂ is not dilated but ovate, rather pointed behind. Near 12-maculata Cl. but differently spotted, shaped and marked.

Mr. Van de Poll had among his material 3 new species of *Haplosonyx* with Mr. Kannegieter's manuscript names attached which have been retained in the following species:

### **Haplosonyx frenbi** sp. nov.

Median sized, light flavous, each elytron with 4 cyaneous blye, round spots, a humeral, two median, placed transversely oblique, and the last ante apical, the spots very lightly edged with brown.

Type 1 example Tandjong-Djati, Ran. Palembang '90, (J. Z. Kannegieter) length 10 mm. Bow. Coll.

Head with obsolete transverse depression but a deep frontal foveæ, antennæ, joints 2, 3, short, equal, thorax sparsely punctured with a deep transverse depression, elytra very obsoletely depressed below the base, thickly strongly punctured with two or three ill defined longitudinal, smooth lines. The markings easily indentify this form.

### **Haplosonyx humeralis** sp. nov.

Much smaller than *Frenbi*, light flavous, antennæ fuscous between joints 2-10, each elytron with a large purplish spot covering the humerus, and sometimes attaining the scutel and extending nearly half the length of the body, inner margin rounded and very narrowly brown.

Type 1 example Tji Solak Wynkoopsbaai (Grelak) also 2 Java Oc. Sukabumi 2000 '93 (Fruhstorfer) Bow. Coll. length 6-8 mm.

Head sparsely punctate, foveate at the vertex, antennæ with joint 2-3 short, thorax sparsely punctate, with usual transverse depression, sides less angulate and more evenly rounded than usual, elytra, without transverse depression, but faintly impressed within the shoulder, thickly and evenly punctate, with in one example obsolete traces of longitudinal lines (♂?). The Grelak specimen is the one with Mr. Kannengieter's name.

### **Haplosonyx monticola** sp. nov.

Large, stout, fulvous, with joints 6-8 of antennæ and tarsal claws brown, elytra brilliant metallic green with cyaneous reflexions, strongly transversely depressed below the base and with semi-regular seriate punctuation.

Types 12 examples Mt. Kina Balu, No. Borneo (Whitehead and Waterstradt) length 13-17 mm. Bow. Coll.

Head with sparse fine punctures, the usual transverse depression divided by a deep fovea, antennæ with 3 joint much longer than 2 (varying in sex) extreme tip dark, thorax with sparse, fine, scattered punctures, transverse depression obsolete in middle, deeply foveate at side, elytra strongly depressed within the shoulders and below the base, producing a tumid effect, punctures impressed but without striæ, fairly regular in front and on the disk, becoming confused at the sidees and obsolete towards the apex, the cyaneous color seems more intense at the sides, elytral margin strongly reflexed and deeply foveate laterally below the shoulder. Easily distinguished by the color and striate elytra.

## **Hoplosoma melanocephalum** sp. nov.

Medium size, shining, light chestnut brown, head, antennæ and feet more or less blackish, the latter especially on the upper side.

Type 8 specimens, Fokien Bow. Coll. length 5-5½ mm.

Head convex, front very finely alutaceous, antennæ half as long as body, 3 joint rather more than twice as long as 2, thorax nearly square, deeply arcuately depressed behind, the sides the most so, also a supplementary fovea on the anterior middle disk, elytra nearly impunctate, lightly depressed below the scutel. The dark head and legs help distinguish this form. In M. Donckier's material labelled with what purports to be Mr. Jacoby's manuscript name which I have preserved. Among the Donckier material is a set of specimens labelled *Hoplasoma 4-pustulatum* Jac. This is *Phyllobrotica* ? *ornata* Jac.

In looking over the new Catalogue of Galerucinæ I am sorry to see generic names like Aulocophora, established for fifty years, superseded by others; and aside from strict priority (if that is granted) the utility of such change seems dubious. *Ceratia* in place of *Triaplatys* does not appeal to me. I retain *denticornis* Jac. in place of *Jacobyi* Wa. and *martia* Ws.=*denticornis* Jac.

Two new forms should be added to this subgenus.

### **Ceratia (Triaplatys) foveata** sp. nov.

Small, ferrugineous, breast and abdomen and 4 spots on the elytra black. Head of ♂ with two large approximate foveae occupying the whole front, limited by a ridge or line between the eyes, antennæ nearly as long as elytra, scape slightly curved and inflated, 2 joint small, rounded, 3d elongate, somewhat curved, flattened and concave in the inside, 4th broad quadrate, concave on the inside edge, 5th triangular, with inside angle truncated, vertex smooth convex, thorax impunctate, deeply transversely impressed behind the middle, less so in ♀ elytra very nearly parallel, not transversely depressed, sparsely and finely punctate, an elongate basal median, and subapical transverse spot, black; neither spot attains the suture or margin. The only ♂ among my examples is on a card, so I am unable to give details of the last abdominal segment.

Types 1 ♂, 3 ♀, Dilli, Port Timor, 2500' (Doherty) iv v also ♀'s from Batjan, Ternate, Timor (Doherty) Bow. coll. Length 3½-4 mm.

The dilated ♂ antennæ and foveate head distinguish this form. *Duboulayi* Baly (not seen by me) is described as having foveate head; the elytral markings are those of *tetraspilota* Baly.

### **Ceratia (Triaplatys) dohertyi** sp. nov.

Similar in coloration to *foveata* supra, ferruginous head, smooth with a deep frontal fovea, antennæ ♂ about ¾ length of elytra, scape somewhat inflated and curved, 2 joint small, rounded, 3 elongate, triangular, flattened, 4 and 5 elongate, rounded on sides and ends flattened, smooth, shining and slightly concave within, thorax smooth impunctate angulate before the middle, deeply transversely grooved at about the middle, elytra slightly dilated behind, slightly depressed below the scutel, and very finely punctulate, a basal patch which does not attain the scutel but usually covers the shoulder and a transverse outer apical patch which does not touch either the margin or suture, black, legs yellow, breast and abdomen black, except the last segment which is deeply cut on either side, and deeply longitudinally channeled in the middle, the extreme ends and edges being yellowed.

Type 1 ♂ Dilli Port Timor 2500 (Doherty) IV V 2 ♂ Dili May '92 Doherty 3 ♀ do Bow. coll. Length 5-6 mm.

The flattened elongate, concave joints of the ♂ antennæ distinguish this form and are a connecting link between species with dilated triangular joints, *denticornsis* Jac. and these with scant dilation like *diversa* Baly.

### **Luperodes pustulatus** sp. nov.

Small, black, thorax and legs rufous, each elytron with three round flavous spots placed in line down the middle, on each side, the one nearest the end sometimes faint or wanting.

Types 5 examples Cordico Bolivia (green label) Bow. coll. Length 3 mm.

Head sparsely finely punctate, finely transversely and longitudinally sulcate, thorax rather transverse, finely punctate, feebly impressed either side behind, elytra very finely punctulate; the spots are placed, one just below the base, the second antemedian, the third on the elytral declivity. The tibiæ and tarsi are more or less brown; the spots easily distinguish this form.

### **Luperodes mapirii** sp, nov.

Small, stout, shining rufous, antennæ, tibiæ and tarsi browned, elytra entirely black excepting a common triangular rufous spots, which begins on the base at the inner shoulder and runs obliquely to the suture at the apical third.

Type one specimen San Augustin Mapiri 3500 ft. 95 (Stuart). Length 3 mm. Bow. coll.

Antennæ slender, joints 2, 3, 4 gradually increasing in length, head and thorax very finely punctate, the latter obsoletely depressed at the sides, elytra finely punctured, obsolete behind, and very slightly transversely depressed, first joint of hind tarsi very elongate, more than half as long as the tibia, apex of all the tibiæ and tarsi brown. Easily distinguished by the color.

### **Luperodes pilosus** sp. nov.

Medium sized, rather stout, nearly parallel sided, black, elytra only, dull dirty yellow, with dusky suture and sides, tending to run together in the middle, sparsely pilose.

Type one specimen Cochabamba, Bolivia Germ. Length 5 mm. Bow. coll.

Head with longitudinal groove on vertex, elongate frontal tubercle between the eyes, antennæ with joints 2, 3, 4 gradually increasing in length, thorax with sides very slightly rounded, upper surface finely punctulate, uneven, with side depressions obsoletely indicated, elytra closely, finely punctate, semi-rugose, the surface showing faint sulcations on the rear half especially on the sides—the pilose elytra easily distinguish this form.

### **Luperodes flavipennis** sp. nov.

Large sized, shining, black, except the elytra and abdomen which are pale yellow.

Type 3 examples Cachabé low. c. xii 96'7 Rosenberg. Length 6-6½ mm. Bow. coll.

Form stout, oval, like *angusto-lineata*, antennæ about two-thirds length of body, slender, 2 joint a trifle more than half as long as 3, front transversely impressed between the eyes, head and thorax sparsely, minutely punctulate, the latter arcuately impressed at the rear, obsolete in the middle, elytra thickly but very finely punctulate, without transverse depression below the base. A well marked form unlike any other.

### **Luperodes hebardi** sp. nov.

Medium size, narrow, and parallel shaped, thoracic margin bright, elytra dull, opake, ochre yellow, head, antennæ, body beneath and legs black, also a shining discoidal thoracic spot, two large sutural spots widened abruptly at the scutel and behind the middle, the lateral margin (not reaching the apex) and three branches from the marginal color, humeral, median and post median black.

*Var. a.* The marginal marking absent, the three branches therefrom, representing three dots, a humeral, median and sublateral at apical two thirds, also the sutural stripe reduced to two common spots, scutellar and submedian.

Type 4 examples Caracas, 1 Venezuela (probably Caracas) var. a 1 example Magdalena Columbia.

Sn Lorenzo Mt. 8500 ft. vii-28-20 (M. Hebard) No. 151 from Mr. Frank R. Mason. Length 4 mm. Bow. coll.

Head punctate with strong cross and longitudinal grooves, antennæ reaching beyond the middle of elytra, joints 2, 3 small, the latter slightly the longer, thorax with arcuate impression, deep at sides, obsolete behind, with marked longitudinal groove, the discal spot attains only the front margin and the sides form the ends of the arcuate depression, the whole surface is shiny but finely punctulate. The elytra dull without luster, or depression, with the black markings sharply defined, in some specimens the sutural edge is very narrowly darkened to the apex. In the var. the thoracic spot approximates to the basal margin. Seems related to *intramarginalis* Kirsch.

### **Luperodes suturalis** sp. nov.

Very like *hebardi* only larger and very similar in looks and markings, the difference being the thoracic spot leaves only the lateral margins yellow, on the elytra the lateral stripe is much thicker and is submarginal, leaving the edge itself yellow, the sutural spots coalesce into a stripe a little widened before and behind, the general effect being to show the elytra black with a narrow lateral border or a sinuate median vitta on each side, joining at the apex, which is broadly yellow, sutural area lightly depressed behind the scutel.

Type 3 examples Marcapata Peru marked n. i. m. in 2nd Jac. coll. Length 5 mm. Bow coll.

Very closely related to *hebardi*, but the general effect is shiny not opake. In one specimen the black oclor shows a tendency to cross the yellow median vitta, the punctuation is very minute while the thorax shows 4 well marked foveæ, 3 where the arcuate depression is, or should be, the 4th apical.

### **Luperodes vittatus** sp. nov.

Very like *suturalis* but with the black color replaced by greenish aeneous, thorax entirely of this latter color margined with yellow and with 3 large foveæ placed 2-1, also a small apical; elytra yellow, with a broad humeral sublateral, and sutural, aeneous stripe, the former not quite attaining the tip the latter becoming very fine at the apex.

Type 4 specimens (green label) Bolivia (Cordico?). Length 5½ mm. Bow. coll.

Head æneous, sparsely punctate, with well marked frontal fovea and cross sulcation, thorax sparsely punctate, more thickly in the foveæ, margined, and sides rounded, the yellow margins broadened at the anterior angles, elytra parallel, smooth, shining, sparsely punctate, the sutural stripe is a little widened at the scutel; the general appearance is of an evenly striped handsome form, body beneath and legs with less greenish tinge.

### **Luperodes bruchii** sp. nov.

Again close to *suturalis*; entirely shining black, except the sides and base of the thorax are yellow, and on each elytron, nearly surrounding the humerus is a triangular yellow patch, partly encircling the humerus (leaving it black) with an agle directed towards but not reaching the suture, the yellow patches on either side leave an even, wide sutural black band a trifle wider at the scutel.

Type 1 specimen Argentine Prov. Catamarca 4-111-07 (Bruch). Length 4 mm. Bow. coll.

Head punctate, with deep transverse and longitudinal furrow, antennæ moderate, joints 2, 3 equal, thorax very sparsely punctulate obsoletely foveate on either side, the ordinary connecting acruate depression very obsolete, the black spot is discal, including the anterior edge, the elytra are finely punctate, somewhat depressed along the suture, but no basal depression, body below not as shining on account of short pubescence.

### **Luperodes klageri** sp. nov.

Small sized, head, thorax and scutel fulvous, antennæ and legs more or less brown, elytra, straw yellow with common sutural and broad humeral sublateral, brownish æneous stripe.

Type 2 examples San Catharine Brazil (Klages) length 2½ mm. Bow. coll.

Antennæ reaching nearly the tip of body joints 2, 3 almost equal, thorax with transverse arcuate depression well marked at the sides, the outward stripe attains the apex in a very fine line, the other vitta stops abruptly, near the turn of the wing cover. Easily distinguished by the size and elytral pattern.

### **Luperodes maculicollis** sp. nov.

Large sized, black ææneous above, thorax yellow except for an anterior discal æneous spot, elytra æneous with an almost straight yellow median fascia, abdomen yellow.

Type 1 specimen Rio Madeira Brazil (Mann & Baker) 1 specimen Porto Velho, Amazons No. 2220 (Prof. Thaxter) Bow. Coll. Length 6 mm.

Head with deep transverse groove between the eyes, vertex evenly and rather strongly punctate, antennæ more than half the length of body, joints 2, 3, gradually increasing in length, remainder elongate, nearly equal, thorax shining, nearly impunctate obsoletely arcuately impressed at the rear, the discal dark spot covers the middle of the anterior margin and is rounded so as to reach the arcuate impression, elytra with bronze color well marked, without transverse depression; the yellow fascia is about ½ mm. wide, very lightly arcuate and does not pass the reflexed margin.

### **Luperodes cyaneoplagiata** nov. sp.

Large sized, fulvous yellow; head, metasternum, tibiæ and tarsi (except the last joint) antennæ joint 2 to 8½ brownish black; elytra with a broad basilar cyaneous basal, and a large cyaneous transverse ante apical spot.

Type 2 examples Cochabamba Bolivia (Germ) Bow. Coll Length 6½ mm.

Head with usual transverse groove, vertex almost smooth, antennæ nearly as long as body, extreme tip of last joint dark, thorax punctulate and depressed at the sides, which are slightly rounded, elytra without depression, thickly and finely punctate, the basal band is a little longer at the sides than the middle, where it is a little short of one third the length, the posterior spot is at the apical third and does not attain either the suture or margin, the rear portion of the elytra including the spot shows faint sulcations; all the legs have the last tarsal and claw joints fulvous.

*Luperodes javanensis* Jac=*Monolepta subra* Gyll next following the description of *M. rubra* Gyll. is ? *flavicollis* Gyll. This seems to be a form of which many examples are in my collection, all apparently coming from North Borneo (Waterstradt), the color is *coccineus* with very light flavous thorax, head with a large, deep, semicircular fovea, anterior femora with a minute tooth. Temporarily I place it in *Monolepta.*

From the descriptions of Monsieur Pic, I mark in my collection of *Crioceris*; *laosensis* Pic=var *impressa* Fabr, *borneensis* Pic=*binotata* Boh, *malaccana* Pic=*seminigra* Jac, *rouyeri* Pic=*dromedarius* Baly, *latefasciata* Pic=*unipunctata* Fabr.

*Luperodes rufescens* Bow. nom. præoc, changed to *weisei* Bow.

### **Luperus masoni** sp. nov.

Small, flavous, antennæ darkened at tip, thorax with two small discal spots indicated, and a long seta on each rear angle, elytra, black, slightly iridescent, all the margins narrowly flavous, the suture and base more broadly than the sides.

Type 1 example Bolivar; Colombia, Cartagena, vii-11-20 Chapparal, Fred Mason, No. 92 Bow coll. Length 2 mm.

Very close to *marginatus* Jac. (type in my coll.) and *albomarginata* Jac. but much smaller than either; the former has a black head and thorax; the latter in addition to being much larger has the elytra much more heavily margined with flavous.

moreover these margins are even and well defined, whereas *masoni* has them narrow and *not* well defined or limited. The Jacoby species has also a dark spot on the breast.

### **Luperus beniensis** sp. nov.

Small, below dirty testaceous, antennæ and body above very dark brown, fairly thickly punctulate, the edges of the elytra especially the sutural, diffusely light colored.

Type 4 examples Reyes, Beni Riv. 7-8-95 (Stuart) 3 specimens labelled Peru, M. Kirsh (2 Jac. coll) Bow. coll. Length 2 mm.

Antennæ ♂ (?) slender, longer than the body, somewhat flavous at base shorter ♀ (?). Again very close to *marginatus* Jac., but that form is black below, less punctured above, with the light margins plainly defined, besides being larger.

### **Luperus pallidus** sp. nov.

Small, entirely dirty yellow, antennæ comparatively short and slightly darkened towards the tip, surface very lightly punctulate, smooth, shiny, no depression on the thorax and only a very obsolete one on the elytra below the inner shoulder, one specimen has the elytral edge slightly darkened, also the abdomen. It is small, insignificant, but the only light colored form rated from South America.

Type 3 specimens Bolivar, Colombia, Cartagena vii-11-20 (F. A. Mason) No. 93. Length 2½ mm. Bow. coll.

### **Luperus blumenensis** sp. nov.

Medium sized, shining black, head, thorax, scutel and base of femora yellow, elytra without depression, thickly and closely punctate.

Type 1 example Blumenau, So. Brazil (Reitter) Bow. coll. Length 4 mm.

Head with smooth shiny vertex, antennæ not reaching the end of the body, joints 2, 3, 4 gradually increasing in length, thorax rather transverse, convex, obsoletely punctulate, the black in the femora is more extended on the upper than the under side, smaller than *xanthaspis* Germ. and more shining.

### **Malacosoma (Exora) cyaneomaculatum** sp. nov.

Medium sized, fulvous yellow, antennæ, tibiæ, tarsi and apex of femora bluish black, the apical third of elytra covered by a cyaneous blue patch, which attains but does not cover the inflexed edge, the basal two thirds with a distinct golden sheen.

Type 3 examples Callanga, Peru, sent me by Messrs. Staudinger and B. Haas as cotypes of *Diabrotica cyaneo-maculata* Jac. (M. S. S.). Length 6 mm. Bow coll.

Head with a deep transverse groove and a few punctures on the vertex, antennæ long, joints 2-3 nearly equal, thorax shining with obsolete basal and lateral depressions and everywhere, finely punctured, elytra closely, strongly, evenly punctate, slightly depressed at the suture below the base, the fulvous part somewhat sheeny. In all probability the specimen sent Mr. Jacoby for identification was *Diabrotica*; this looked like it superficially and were so sent out by the dealers.

### **Malacosoma (Exora) basale** sp. nov.

Large sized, deep orange yellow, antennæ except (first 2 joints) (last 3 lacking) tibiæ and tarsi blackish blue, elytra very closely coriaceously punctate, base broadly cyaneous purple, or blue.

Type 1 example Santa Fe de Bogota, 1 in the 1st Jac. coll. Bogota; 1, 2nd Jac. coll. no locality, the last two specimens have the purple confined to a broad basilar band and this I regard as the typical form. The first specimen, which is the most perfect, has the dark color extended nearly to the apex. Length 9-10 mm. Bow. coll.

Head with well marked transverse groove, at vertex sparsely, finely punctate, antennæ with 3 joint twice length of 2, thorax transverse, sides nearly straight very finely sparsely punctulate, depressions only indicated, elytra, stout, parallel, without depression, coriaceous, the yellow color has more or less metallic sheen. A fine well marked form, *dubia* Oliv. seems to be smaller and smooth.

### **Malacosoma** (**Exora**) **guttatum** sp. nov.

Medium sized, dark chestnut brown, head except the lower face, and metasternum black, elytra very thickly punctate, normally with two elongate parallel black spots on each side, one humeral, the other basilar and almost touching the end of scutellum and parallel to the first spot and the suture, this 4 spotted is the normal form, varieties occur where there is a further double series of spots, in direct extension of the normal spots, these additional spots are median and ante apical.

Type Rio Janeiro, Espirito-santo, Brazil, 2 labelled Miers. Coll. represent the most spotted vars. 6 specimens in all. Bow. coll. Length 7 mm.

Head with transverse depression and frontal fovea, vertex shining, nearly impunctate, antennæ more than half the length of body, joints 2, 3 equal, first 3 or 4 joints rufous, rest black, thorax same shape as *obsoleta*, shining nearly impunctate, elytra without depression, the punctuation a trifle obsolete at apex, in *obsoleta* the sutural spots are *subbasal* and do not attain the margin, in *guttata* they always start *at* and *include* the margin.

### **Malacosoma** (**Exora**) **quadripustulatum** sp. nov.

Small, black, head and thorax rufous, each elytron with two large flavous spots, one triangular subhumeral, with apex near the suture, the other oval, midway between the middle and apex.

Type 1 example Rio (2 Jac. coll.) 2 Misiones Prov. Argentine, Bow. coll. Length 4½-5mm.

Head with front more or less darkened, antennæ nearly as long as body, joints 2, 3 equal, thorax sparing punctulate, sides very nearly straight, elytra finely punctate, depressed along the suture, below the scutel, the spots rest on the inflexed margin and do not attain the suture.

### **Malacosoma (Exora) rosenbergi** sp. nov.

Medium sized, yellowish fulvous, antennæ, knees and tibiæ and tarsi dark brown, elytra with two rufous stripes on each side the first sublateral from the humerus to below the middle, the second almost median curving outward below the middle, but not quite joining the first.

Type 3 examples Cachabé low c xii-96 and i-97 (Rosenberg), Length 5½ to 6 mm. Bow. coll.

Head transversely sulcate, vertex almost impunctate, antennæ with joints 2, 3 nearly equal, thorax with form of *encaustica*, almost impunctate, elytra thickly and evenly punctate, without depression, the suture very narrowly edged with rufous; the first stripe begins on the shoulder and running nearly parallel to the edge, ends at the curve of the elytra; the second begins below the base at about the middle and runs straight to a little below the middle half, when it curves gracefully outward, so that (if prolonged) it would join the first. The apex is ciliate with a few fine hairs, the under edge of the epipleuræ is also narrowly rufous, the color of the brown parts varies tending to become rufous. The curved stripe easily separates this form.

### **Malacosoma (Exora) buckleyi** sp. nov.

Medium sized, brown, head (except the labrum) black, elytra with a large ill defined humeral, and an oblique ante apical patch blackish blue, breast more or less black.

Type 3 examples Yurimaguas, Peru (Buckley). Length 6½ mm. 2 examples Surinam (Fruhstorfer) (2 Jac. coll.) Bow. coll.

Head with strong transverse depression and frontal calli, vertex finely punctulate, antennæ moderate, joints 2, 3 nearly equal, thorax transverse, slightly angulate at the middle, very obsoletely depressed and punctulate, elytra moderately punctate, showing traces of longitudinal sulci here and there, the extent of the dark area varies greatly being in one specimen extended along the side and towards the suture and in another reduced to a mere wisp on the shoulder and the same with the rear spot, the forms with a minimum of dark have rather stronger punctuation. There seems no particular distinctive feature to this form. The Surinam examples are smaller and darker colored, only the sutural area being indefinitely lighter.

### **Malacosoma bellum** sp. nov.

Medium sized, rufous, antennæ, apex of tibiæ and tarsi darkened, elytra closely finely punctate shining violet purple.

Type ♂, ♀ Rio Janeiro, Brazil (Klages ?). Length 5-5½ mm. Bow. coll.

Head with well marked transverse impression, with convex nearly smooth vertex, antennæ moderate length, joints 2, 3 equal or nearly so, 3 basal rufous; thorax transverse, smooth shining convex, almost without trace of depression or punctures, elytra parallel, impressed within the shoulder and very slightly at the suture below base, punctuation obsoletely seriate on the ♀ disk, the suture very narrowly cyaneous. I should have referred this form to *dubia* Oliv. if that did not call for *smooth* elytra.

### **Malacosoma (Exora) simile** sp. nov.

Medium sized dull fulvous, antennæ, 4 spots at base of elytra and 4 anteapical black

Type 1 ♂ Caraca, Brazil. Bow. coll. Length 5½ mm.

Head scarcely depressed between the eyes, vertex convex smooth, antennæ (last 4 joints missing) 2, 3, very small, nearly equal, remainder elongate, thorax transverse, smooth, almost impunctate elytra very thickly evenly punctate like *guttata*, an elongate spot at the shoulder and a round one either side of the scutel, and 4 placed transversely just before the apex. *Guttata* is larger, has a black head and breast and light antennæ, *similis* has black antennæ and light head and breast.

### **Malacosoma (Exora) octoguttatum** sp. nov.

Small, chestnut brown, antennæ dark, elytra with four elongate spots at the base (2 each side) and four round spots transversely placed just behind the middle.

Type 1 specimen Rio Janeiro, Bow. coll. Length 5 mm. var. A, So. Brazil, anterior spots joined, forming a band and rear spots a lunule.

Antennæ nearly as long as body, joints 2, 3 nearly equal, front of head and thorax convex smooth, elytra smooth shining obsoletely punctate, the basal spots are humeral and next the scutel, the other spots are placed evenly in line just back of the middle; near *similis* and *guttata* but without the elytral punctures of either, and the rear spots are much nearer median.

### **Malacosoma (Exora) maculatum** sp. nov.

Size of *olivacea*, color light yellow, elytra alutaceous with punctuation, antennæ, tibiæ and tarsi, scutel and 5 spots on each elytron black, body beneath more or less brown on the breast and segments, thorax with 5 spots indicated in dark red.

Types 5 examples San Augustin, Mapiri, 3500 ft. ix 95 Stuart. Length 6 mm. Bow. coll.

*Var. a*, thoracic spots shown in brown, median spots on either side joined. Cochabamba, Bolivia, Germ.

Antennæ about two-thirds length of body, joints 2, 3 about equal, upper joints lighter color, head with well marked transverse groove, vertex convex, thorax with wide, though not deep, median lateral foveae and with 5 spots indicated in color, 2 lateral, 2 median with an apical between, scutel black, elytra with punctuation more marked, but still semi shiny, the spots on each side are a subbasal humeral and median, two median directly in their rear and the fifth large rounded, subapical, in the variety the median are joined together, and the thoracic spots are brown; near *olivacæ* Oliv. but that species has 4 series of spots and this only 3.

*Chthoneis* Baly, as at present used, seems to contain rather incongruous forms. It was founded upon *apicipennis* from Colombia this species has joints 2, 3 of antennæ very short, equal, the following joints compressed and elongate; a smooth thorax and unarmed hind tibiæ, then followed species with foveate, thorax (albicollis) in 1880 Jacoby added *apicalis* (type in my coll.) (also Godman and Salvin, Brit. Mus.?) though apparently with some latent doubt; the antennæ are (in my specimen ♂ ?) very different from the typical form and the hind tibia have a short spine, in the Biologia, Jacoby adds two Mexican forms, *dilaticornis* where the ♂ has distorted antennæ, both this and *jansoni* have a rather slender elongate body tending towards *Luperus*; on the other hand *Luperus fucatus* Er. I remove to Chthoneis. There are several new forms which are closely allied to the foregoing.

### **Chthoneis grossa** sp. nov.

Size, form, and structure of *apicalis*, Jac, rufous, the edges of the elytra and thorax a little yellowed, antennæ, tibia and tarsi and nearly the whole of the abdomen black; rufous part of the elytra with a distinct iridescent tinge.

Type 1 specimen, Brazil (Mann) Bow. coll. Length 10 mm.

Head with transverse groove between the eyes, vertex sparsely and finely punctate, antennæ barely two-thirds length of body, 2 joint short, 3 half longer, remainder elongate and somewhat compressed, thorax (exactly like *apicalis*) transverse, all the angles prominent, sides slightly rounded, depressed anteriorly on either side, and with a median posterior fovea and anterior longitudinal sulcation, whole surface punctate, scutel almost smooth, elytra much wider than the thorax, without any depression, very thickly evenly punctate, the hind tibiæ have a small but distinct spine. The claws are appendiculate.

The future will probably separate both this form and *apicalis* from the present genus. I merely follow Mr. Jacoby.

### **Chthoneis marginipennis** sp. nov.

Medium sized, black, with epipleuræ, reflexed edge of elytra to the tip, the basal margin, and suture so as to enclose the scutel, white.

Type 1 example Gua. (G. D. Smith) Bow. coll. Length 6 mm.

Antennæ not quite as long as body (♀) ? 3 joint longer than 2, first few joints narrowly white at base, head sparsely punctate with a deep frontal fovea, thorax transverse, thickly coarsely punctate, deeply foveate either side of the middle and with a moderate subapical depression, scutel smooth, elytra thickly and evenly punctate, more finely than the thorax, quite strongly impressed within the shoulders and somewhat along the anterior suture, so that the scutellar area seems prominent. Rather an intermediate form but easily recognized by its color.

### **Chthoneis foveicollis** sp. nov.

Moderate sized, elongate, rufous, antennæ, tibiæ, and tarsi blackish purple, elytra very closely punctate, purple violet, semi alutaceous.

Type 1 example (♀) San Augustin, Mapiri 3500 ft. 1-95 Stuart. Bow. coll. Length 8 mm.

Belongs near *dilaticornis* Jac. being of the same elongate form, head sparsely punctate, with frontal fovea and transverse depression, antennæ not quite as long as body, joints 2, 3 equal, though not very small, thorax transverse, sides slightly rounded, surface rather thickly punctured with 4 fairly well defined foveæ, an apical and basal and lateral median, elytra slightly impressed within the shoulders and on the suture below the base, very obsoletely sulcate toward the apex.

### **Chthoneis stuarti** sp. nov.

Small, head rufous with black spots on the labrum and vertex, antennæ black, apical joints white, body below black, legs black with basal two-thirds of femora rufous, thorax rufous, scutel and elytra black, very slightly viridi-æneus.

Type 4 examples Reyes 7-8-95 (Stuart). Length 4½ mm. Bow. coll.

Head with deep transverse groove at the top of the eyes, vertex finely and sparsely punctate, antennæ longer than the body ♂, shorter ♀, 3 joint half longer than 2 (like *apicalis*) extreme tip of 11 and base of 9 dark, intermediate joints ♂, dilated and lengthened (fairly typically), thorax convex, shining, sparsely punctulate, distinctly foveate either side at the middle, elytra faintly impressed within the shoulder, very thickly evenly punctate, first joint of front and middle tarsi dilated ♂. Intermediate between the strictly typical forms and the elongate Mexican, like *Jansoni* Jac.

### **Chthoneis rufulum** sp. nov.

Small, entirely rufous—flavous, except the eyes, which are black and the antennæ after the third joint dark brown.

Type 1 example ♂, So. Brazil. Bow. coll. Length 4 mm.

Head with frontal fovea between the eyes, antennæ longer than the body, strictly generically typical, i. e. joints 2, 3 very small, equal, subsequent joints dilated and elongate, thorax convex, transverse, smooth, with a very obsolete lateral fovea, elytra smooth, shining, sparsely finely punctulate, very obsoletely depressed at the suture below the base. This form is at once separated by its size and color.

### **Chthoneis boliviensis** sp. nov.

Small, æneous brown, elytra cyaneous blue, lower face, last 2 joints of antennæ (except extreme tip) sides of the thorax, and femora pale yellow.

Type 4 examples San Augustin, Mapiri 3500 ft. 95, Bow. coll. Length 4½ mm.

Head smooth, with usual cross depressions, and fovea, antennæ elongate, joints 2, 3 very short, equal, remainder elongate, compressed, vertex shining, almost impunctate, thorax shining sparsely punctate, obsoletely depressed on the sides and disk, the former narrowly flavous, this color impinging upon the base in a fine line, elytra slightly depressed at the scutel, parallel, surface very closely strongly punctate and rugose.

Like *marginicollis* Jac. but very much smaller.

### **Chthoneis rosenbergi** sp. nov.

Medium sized, elongate parallel, lower face and thorax rufous, last 4 joints of antennæ and legs flavous, upper head, and body below black, elytra dark blue.

Type 8 specimens Cachabè low c. xii 96 (Rosenberg) Length 7 mm. Bow. coll.

Head with swollen shining vertex, antennæ about as long as body, nearly typical, joints 2, 3 short, equal, thorax nearly smooth, shining, deeply foveate each side at middle (like *bivittata*) elytra very closely, strongly punctate, legs flavous with extreme tarsal joint and claw dark, the same elongate form as the Mexican species of the Biologia.

### **Chthoneis donckieri** sp. nov.

Medium sized, rufous, antennæ, tibiæ and tarsi purplish black, elytra bright purplish violet.

Type 8 specimens Cochabamba, Boliv. Germ. Length 4½-5 mm. Bow. coll.

Head with vertex finely punctate, antennæ nearly as long as body ♂, shorter ♀, joints 2, 3 short, equal, remainder elongate, compressed, thorax convex, shining, rather strongly punctate, moderately foveate on either side at the middle; elytra feebly impressed within the shoulder, very thickly evenly and strongly punctate, close to *æneipennis* and possibly only a variety of that form. Was among the material sent me by M. Donckier.

### **Chthoneis æneipennis** sp. nov.

Medium sized, elongate, parallel, shape of *jansoni* Jac. Head, thorax, base of femora, pro, and meso thorax rufous, antennæ black, except last 3 joints white, elytra very closely punctate, æneous, body beneath and legs except as above black.

Type many examples Cochabamba Boliv. (Germ.) Bow. coll. Length 5-5½ mm.

Head with frontal fovea and sparse punctures, antennæ about as long as body, 2 joint not very small, 3 half longer, following joints dilated, extreme apex dark, thorax convex, nearly smooth, distinctly foveate each side at middle, elytra more or less distinctly impressed within the shoulder, the surface very closely and at the sides rugously punctate.

### **Scelolyperus tenuimarginata** sp. nov.

Long, parallel, straw yellow; tibiæ, tarsi and upper sides of femora dark brown, abdomen and metosternum metallic cyaneous with gray pubescence, epipleura, the reflexed edges posteriorly, and the suture for apical two thirds, very narrowly edged with metallic greenish black.

Type 1 ♂ example Brazil ♀ (2d Jac. coll.) Bow coll. Length 8 mm.

Head with long well marked longitudinal furrow, antennæ long and slender (4 upper joints missing), thorax broader than long, smooth with vague lateral impressions, elytra thickly rather coarsely and confusedly punctate with numerous obsolete costæ, especially indicated towards the middle, the metallic coloring below is almost similar to that of S. *bella* Jac. and S. *viridis* Jac. In the shape of the thorax this species is allied to S. *flava* All. from Argentine, which is not strictly typical in the shape of the thorax.

### **Scelolyperus rosenbergi** sp. nov.

Medium sized, black, with lower face, thorax, joints 9-11 antennæ (except tip), fulvous or yellowish white, elytra dark purplish blue, very closely, thickly and rugosely punctate with two or three obsolete costæ, of which the most marked is one at apical third, a little the lateral side of the middle.

Type 1 example Cali, Colombia ix-xii-94 Rosenberg. Bow. coll. Length 7 mm.

Head with vertex almost smooth, in certain lights tinged with greenish, antennæ graceful, nearly as long as body, joints 2, 3 almost equal, thorax rather transverse, smooth, convex, almost impunctate, the scutel is smooth, the punctuation of the elytra, excepting the costal indications is similar to *bella* Jac.

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